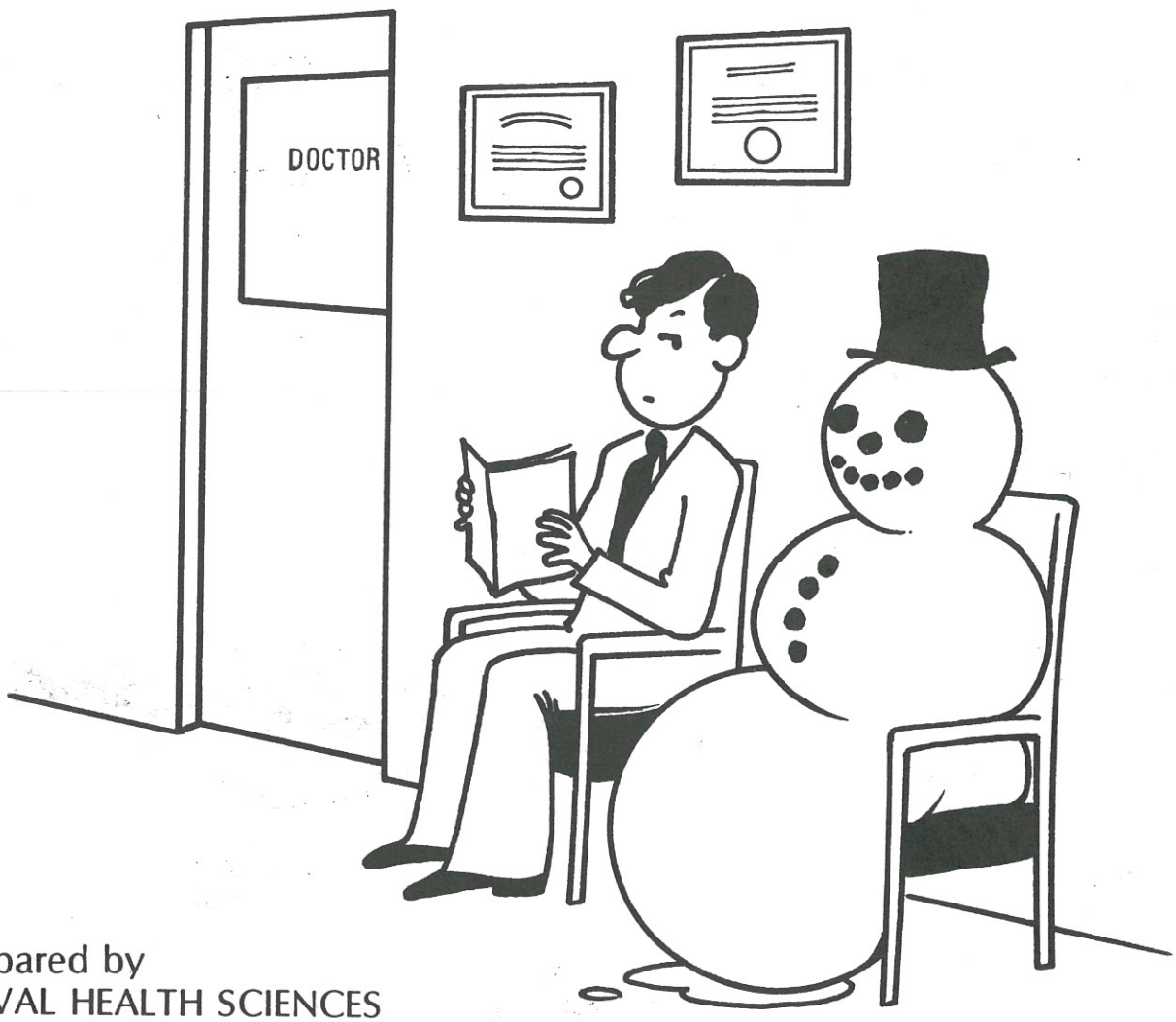
Lee Taylor

Cold Weather Medicine



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COLD WEATHER MEDICINE

An Instructional Program for
U.S. Navy Medical Department Personnel

NAVAL HEALTH SCIENCES EDUCATION AND TRAINING COMMAND

National Naval Medical Center

Bethesda, Maryland 20014

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PREFACE

The effectiveness of the Navy Medical Department in fulfilling its Operational Medicine commitment depends upon the medico-military expertise of its personnel.

Cold weather survival demands organization for the maximum saving of body heat with shelter and insulation, maximum use of available food and fuel sources, and minimum waste of body energy. This organization can be achieved only by knowledge and the practice of safety and preventive standards developed for cold weather operations.

The goal of this cold weather medicine program is to provide Medical Department personnel with the necessary knowledge and information resources to effectively participate as cold weather medicine support personnel in severe climatic operations.

This program can be used for either self-study or a classroom course. The format and contents are intended to guide and assist the user in selectively choosing those parts of the program relevant to his particular professional and operational needs. Included are objectives, instructional materials, lecture outlines, a glossary, an annotated bibliography, and an information source list.

The program is divided into five areas, each supporting a basic theme of prevention:

I. Factors Influencing Cold Region Adaptation.
II. Factors Encouraging Cold Region Adaptation.
III. Basic Needs.
IV. Disturbances Due to Cold.
V. Acute Minor Illnesses and Trauma.

Self-study users should thoroughly familiarize themselves with the following parts of this program:

1. Objectives of each unit.
2. Glossary (page 100).
3. Annotated bibliography (page 114).
4. Information source list (page 130). This list tells you how to obtain item 5, publications and films.
5. Correspondence courses, "Low Temperature Sanitation and Cold Weather Medicine" and "Cold Weather Operations."
6. Textual materials (pages 135 to 174):
   A. Simplified Cold Physiology
   B. Cold
   C. Immersion Foot
   D. Resusitation of Accidental Hypothermia Victims

TASK RESPONSIBILITIES OF NAVY MEDICAL DEPARTMENT PERSONNEL IN COLD REGION OPERATIONS

Develop a personal understanding and working knowledge of cold weather medicine in military operations.

Conduct all-hands training programs in the prevention of cold weather related injuries, accidents, and conditions.

Monitor and supervise all personnel in the prevention of cold weather related injuries, accidents, and conditions.

Diagnose and treat cold weather induced injuries, accidents, and conditions.

Serve as a consultant regarding health care matters of personnel participating in extreme, cold environment exercises.

Make recommendations to appropriate operational command authorities for. . .

(1) development of cold weather training programs.
(2) provision of basic needs for operational personnel.
(3) development and maintenance of medical supplies and equipment.
(4) development of specific cold injury treatment protocols.

Participate in cold related medical and health problems research by. . .

(1) identification of health maintenance problem areas.
(2) collection of health problem data through the maintenance of accurate records and meaningful statistics.
(3) recommendations of new and successful cold injury treatment protocols.

AREA I. FACTORS INFLUENCING COLD REGION ADAPTATION

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize those factors that influence cold weather adaptation, and use that information to maintain an optimal state of well-being and operational readiness in any cold region assignment.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Define the epidemiological factors of cold injury as agent, environment, and host.

2. Describe kinds of cold as wet and dry.

3. Describe the effects of cold and its relationship to body heat production and conduction.

4. Define convection, conduction, radiation, and evaporation.

5. Interpret the effects of the environmental factors of meteorological, geographic, and occupational activity as they relate to cold operations.

6. Describe ambient temperature, the effects of humidity, wind in the presence of cold, and the wind chill phenomenon as they relate to body heat loss.

7. Describe the effects of cold as it is altered by various geographic features of the environment.

8. Distinguish the effects of various occupational activities as they affect the incidence of cold injuries.

9. List the eleven host factors that may influence cold adaptation and the possible occurrence of cold injuries.

10. Describe the effects of age, race, and geographic origin on the development of cold injuries.

11. Describe the psychological factors that appear to encourage and discourage the development of cold injuries.

12. Describe the effects of discipline, training, and experience on successful cold adaptation.

13. Describe the relationship of rank and the incidence of cold injuries.

14. Describe the progression of fatigue as a cold injury host factor.

15. Describe how concomitant injuries encourage the development of cold injury.

16. Describe the effect of previous cold injuries as a cold injury predisposing factor.

17. Describe cold region activity as an injury preventive factor and an injury predisposing factor.

18. Describe the effects of drugs, medications, and alcohol as potential cold injury predisposing factors.

19. Describe the nutritional requirements of cold region operations as caloric, and specific kinds of food requirements.

INSTRUCTIONAL MATERIALS

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Manuals/Pamphlets

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US Coast Guard: A Pocket Guide to Cold Water Survival. Washington, DC, US Government Printing Office, 1976, pp 1-20.

US Navy: Cold Injury, NAVMED P-5052-29. Washington, DC, US Government Printing Office, 1976, pp 1-3.

LECTURE OUTLINE

I. Introduction. A study of man's military history in cold regions leads to one basic conclusion--his successes and failures are measured in terms of his regard for one dominant characteristic: COLD. The man who recognizes and respects the forces of the environment can do his job and even use these forces to his advantage. The man who disregards or underestimates these forces is doomed to failure, if not destruction. Cold adaptation begins with a knowledge and understanding of these factors: agent, environment, and host.

I. Factors influencing cold region adaptation

A. Agent. COLD is the specific agent factor.

1. Kinds of cold

a. Wet cold. Conditions that occur when temperatures are near freezing and variations in day and night temperatures cause alternate freezing and thawing. These conditions cause the ground to become slushy and muddy.

b. Dry cold. Conditions that occur when temperatures are below freezing. The ground is usually hard and the snow dry.

2. Effects of cold. If the effect of cold is considered as a loss of body heat, an agent relationship with modes of heat production and heat conduction is apparent. As such, the effect of cold cannot be evaluated by ambient temperature alone.

a. Heat production in the body is regulated by both physical and chemical mechanisms.

b. Heat conduction or loss from the body is regulated by four mechanisms:

(1) Convection - heat loss as air currents pass over the skin

(2) Conduction - heat loss by direct contact of skin with cold objects

(3) Radiation - heat loss to the air independent of air movement

(4) Evaporation - loss of heat carried by body moisture in expired air or perspiration

B. Environment - includes those factors which externally influence the effect of cold on living things, whether plant, animal, or man.

1. Meteorological factors - such data as temperature, humidity, wind, precipitation, and ground conditions

a. Ambient temperature is affected by wind and wetness.

b. Temperature in the presence of humidity inhibits the evaporatory effect of the body in ridding itself of perspiration. In cold environments perspiration contributes to body heat loss.

c. Temperature in the presence of wind has a marked cooling effect on the body. This effect is called the wind chill phenomenon. Wind velocity accelerates body heat loss under both wet and cold conditions.

(1) The overall action of the wind chill phenomenon is a loss in total body heat.

(2) The specific effect of wind chill as calculated on the wind chill chart relates to the cooling effect on exposed skin.

2. Geographic factors relate to the natural features of the earth.

a. Altitude. Effects of cold temperatures are intensified at high altitudes.

(1) Mountains. Incidence of acute mountain sickness is increased in frequency and sevèrity proportionately with speed and height of ascent.

(2) Flying. Inflight problems are the result of both altitude adjustments and the effect of the cold

weather apparel worn by personnel. Heavily clothed personnel perspire in overheated aircraft cabins and consequently lose the insulative effect of the clothing when disembarking from flight to cold environments.

b. Flatlands, plains, deserts. The nature of these geographic surfaces affords little protection from wind and blizzards. Although desert environments are not considered "cold regions," extreme fluctuations between day and night temperatures can create a cold injury situation. Personnel sleeping in inadequate shelters have been known to experience hypothermia reactions as night temperatures drop.

c. Waterways, floating ice. All are potential cold water immersion hazards.

3. Clothing and occupational activity are both considered as environmental factors. Clothing will be discussed in detail in another unit. For military purposes, types of combat or drill activity are occupational activities.

a. Reserve/rest units have few cold injuries.

b. Holding/static defense units have a moderate increase in cold injury.

c. Active defense units have a marked increase in cold injuries.

NOTE: The pattern above is consistent with the fact that, as combat activity increases, the length and degree of exposure also increase.

C. Host - those factors in which individual characteristics influence cold adaptation and the subsequent occurrence of cold injury

1. Age does not appear to have a significant effect.

2. Race. Historical analysis suggests that Negroes are more susceptible to effects of cold in severe environments; this has not been factually established. Some experts suggest that the increased incidence of cold injuries in blacks is the result of psychological/educational factors.

3. Geographic origin. Personnel from areas where the mean January temperature is above 20° F appear to have a predisposition for cold injuries. This tendency may be the result of psychosocial/educational factors, rather than geographic origin.

4. Psychosocial factors. Personality and motivation are probably the most significant psychological factors that determine a person's adaptability in severely cold environments.

   a. High motivation is the most important single factor.

   b. Personality types

      (1) The active, pioneer type adjusts best.

      (2) Passive, negativistic individuals tend to be more susceptible to cold injuries.

      (3) Personnel with a history of psychiatric problems should not be sent on long, cold region assignments.

      (4) During short, cold region deployments, types (2) and (3) above should be closely supervised in cold injury preventive methods.

   c. Psychological preparation for cold region assignments should include:

      (1) Development of a positive attitude toward the assignment

      (2) Development of a degree of mental discipline to ensure unquestionable ability to follow orders and instructions

5. Discipline, training, and experience

   a. Training and discipline markedly affect incidence of cold injury.

      (1) Physical conditioning and training programs provide personnel with physical and mental ability to conserve body heat in a variety of environmental situations.

(2) Discipline conditions personnel to use this ability in appropriate situations, e.g., altitude, severe cold, wet cold, dry cold, etc.

b. Experienced personnel in cold regions know the value of training and discipline. Experience has not only conditioned them mentally and physically, but also provided them with a certain sagacity regarding the cold.

c. Training, discipline, and experience are the building stones for leadership. In no other environment of the world is individual leadership more important. Most effective is leadership by example.

6. Rank. The noticeable decrease in cold exposure problems among higher ranking personnel is probably the result of experience and receptivity to training. Generally, higher ranking personnel are in billets that subject them to lesser degrees of exposure.

7. Fatigue. Mental and physical weariness contribute to apathy, which leads to neglect in personal survival or preventive cold injury activities.

8. Concomitant injury. Significant bleeding, pain, and/or shock resulting from other than cold injuries are cold injury predisposing factors.

9. Previous cold injury increases the risk of a repeated episode, particularly frostbite and immersion foot injuries.

10. Activity

a. Overactivity leads to increased perspiration, which contributes to loss of the insulative protection offered by clothing.

b. Underactivity leads to a decrease in the body heat producing activities, thus allowing a shell-to-core cooling.

11. Drugs, medications, and alcohol. Those substances which affect the peripheral circulation or the mechanism of perspiration create a climate for cold injury to the body.

12. Nutrition. Well nourished personnel require minimal nutritional adjustments in cold regions.

a. Severe energy expenditure activities (e.g., cross country skiing) will require a slight increase in caloric intake.

b. An increase in fat intake (not caloric) has been recommended for prolonged cold environment operations.

c. Personnel with subcutaneous fat layers appear to have a natural cold insulative ability, as opposed to extremely lean personnel.

d. Since food is fuel for heat production, lack of food means a gradual decrease of fuel and subsequent body core heat. Semistarved personnel are extremely vulnerable to cold injury.

AREA II. FACTORS ENCOURAGING COLD REGION ADAPTATION

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize those factors that encourage cold weather adaptation, and to use that information to maintain an optimal state of well-being and operational readiness in any cold region assignment.

Instructional Objectives

At the end of this unit, the student will be able to:

1. List the administrative responsibilities of command authorities regarding cold weather operations.

2. Describe the responsibilities of command authorities regarding logistics, training, and delegation for cold weather operations.

3. Describe the relationship of administrative and personnel factors in cold weather operational planning.

4. Describe cold weather training as it involves physical conditioning, acclimatization, and other adjustments.

5. Describe the effects of various levels of exercise in wet and dry cold environments and the relationship of exercise to physical conditioning.

6. Discuss current ideas regarding the method and value of preoperational acclimatization.

7. List and discuss the four basic rules that contribute to functional and successful cold region adaptation.

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US Coast Guard: A Pocket Guide to Cold Water Survival. Washington DC, US Government Printing Office, 1976, pp 1-20.

US Navy: Cold Injury, NAVMED P-5052-29. Washington DC, US Government Printing Office, 1976, pp 4, 5.

LECTURE OUTLINE

I. Introduction. The success of any cold region operation requires vigorous command leadership, prior planning, cold weather training, and the effectiveness of the officers and men who must be in good health, physically fit, and mentally alert. Those personnel undertaking cold region operations, particularly for long periods, should recognize the need for self-discipline. This is a matter of mental attitude and cannot be taught in the classroom.

II. Factors encouraging cold region adaptation

A. Command responsibility. Commanders responsible for cold region operations must be aware of the demand for a dual commitment in severe environmental operations. The obvious terminal goal, in any military operation, is a successful mission. However, cold region operations require a dedicated commitment on the part of commanders to the prevention of cold injuries. The command's responsibilities include providing the following:

1. Proper and sufficient clothing, supplies, equipment, and transportation resources

2. Cold weather training programs. Because of the special factors introduced by cold environments, training differs widely from that in temperate zones. Higher standards of physical fitness and cold injury preventive measures must be stressed. (Both are discussed in detail throughout this program.)

3. Designation of the Cold Injury Control Officer. This person can be a commissioned or noncommissioned officer carefully selected for leadership and supervisory ability. His responsibilities include:

a. Observe personnel frequently for early signs and symptoms of cold exposure problems

b. Check personal hygiene daily

c. Encourage periodic exercise activities

d. Discourage habits, positions, and activities with a cold injury potential (e.g., smoking, over-exercising)

e. Ensure that the "buddy system" is functioning properly and effectively: members of squads, patrols, etc., observe each other for physical signs that warn of cold injury, such as sudden blanching of the skin.

B. Individual responsibility. In essence, the command provides materials, information, and resources. The individual must use such materials, information, and resources properly and effectively.

1. Materials and resources, such as clothing and shelter, are discussed in detail in another section of this program.

2. Information results from training. Training--whether physical, mental, or both--properly used is directly related to cold region adjustment.

a. Physical preparation. The body's ability to adjust to any physiological stress environment is influenced greatly by its physical condition. Physical conditioning and training programs have a positive effect on the body's conservation of energy. By developing the body's ability to adjust and/or maintain temperature, blood pressure, and oxygen consumption through physical conditioning training, vital energy stores are conserved.

(1) Prolonged exercise contributes to heavy perspiration and mental and physical fatigue. These in turn contribute to increased body heat loss and create a cold injury hazard. For example, if the individual is physically active, cooling develops with fatigue and, as exhaustion approaches, the vasoconstrictor mechanism is overpowered and sudden vasodilation occurs with resultant rapid loss of heat. Critical cooling then ensues.

(2) Total immobility and lack of exercise create non-heat-producing situations and consequently create potential cold injury conditions. For example, if activity is restricted, the extremities, notably toes and fingers, approach freezing temperatures most rapidly. A depression of general body temperature follows.

(3) Excessive activity of the extremities during cold water immersion contributes to severe and rapid body heat loss.

(4) In essence, physical conditioning and maintenance problems should be prudently engaged in with flexibility and moderation. Each situation must be evaluated in light of survival and cold injury prevention priorities.

b. Acclimatization is the process that allows the body to adjust physiologically and adapt itself to a different environment.

(1) Total cold region acclimatization is an extremely complex process, not completely understood. Much research has been done and continues.

(2) For military operational purposes, the most effective and efficient method of acclimatization consists of physical training in outdoor environments with a gradual increase in duration of exposure and decrease in environmental temperatures.

(3) The recommended time frame for acclimatization training is about 2 weeks. Adequate acclimatization can occur following a few days of exposure. It has also been known to take months or years, and in some cases has never been achieved.

c. Other adjustments. To remain functional in the cold, the human body must be protected. It must be kept clean, dry, warm, rested, and well nourished. The right approach to cold weather living consists of four basic rules that will keep personnel healthy.

(1) KEEP IN SHAPE. Cold weather clothing is heavy. Just walking with that extra weight burns a lot of energy. By keeping fit, personnel will be able to perform effectively with minimal energy waste.

(a) A sleeping man will not freeze unless he is exhausted.

(b) A healthy man will awaken long before he reaches the danger point of freezing.

(2) DRINK PLENTY OF WATER. Because of the unavailability or inconvenience of drinking water resources in cold regions, personnel have a tendency not to drink enough. Often the normal thirst mechanism is suppressed in extremely cold weather. In cold

climates personnel normally ONLY drink when they are thirsty. Often this is not enough to ward off dehydration. Dehydration is a major predisposing condition for the development of serious cold injuries.

(3) EAT TO KEEP FIT. Regular, satisfying, hot food is essential for top performance. Eating habits should be regular. A well balanced diet is imperative to supply the essential food constituents and energy necessary to maintain a state of health in cold regions.

(4) MAINTAIN A HEALTHY ATTITUDE. A positive healthy mental attitude not only contributes to survival, but also provides man with a self image which programs thoughts and actions for coping with any reasonable situation. The human mind is incalculably powerful and can surmount most obstacles and trials.

AREA III. BASIC NEEDS

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to interpret basic needs as they are influenced in cold regions and to use that information to develop a pattern of daily living activity that will ensure a physically safe and professionally satisfying operational experience.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe oxygen and its role in basic survival and health maintenance.

2. Describe the concept of shelter and list the various kinds defined in the concept.

3. Describe the principles and functions of the various kinds of shelters as they relate to heat conservation and loss.

4. Describe the basic requirements of structural shelters as they relate to survival and safety needs.

5. Describe the fire prevention protocols required for safe cold region habitation.

6. Describe water and its role in basic survival and health maintenance.

7. Describe some cold region potable water sources and conservation practices.

8. Describe the role of hygiene and sanitation as they affect health maintenance.

9. Describe the role of food as it relates to cold region requirements, sources, and sanitation practices.

10. Describe safety and security as psychological needs in cold region operations.

11. Describe the need for personal security as a therapeutic agent of cold region psychological stress.

12. Describe the factors affecting occurrence of foreign body injuries during cold region operations.

13. Describe the criteria for amassing first aid materials.

14. Describe medical material needs that would enhance cold region medical personnel support.

INSTRUCTIONAL MATERIALS

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Manuals/Pamphlets

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LECTURE OUTLINE

I. Introduction. Survival is staying alive. In no other environment is a consistent awareness of survival needs more important than in a cold region. Basic needs can be classified as physiological and psychological. In many cold weather situations, the physiological and the psychological are directly dependent upon each other.

II. Physiological needs

A. Air. Breathing is essential to maintain life on a minute-by-minute basis.

1. Oxygen is the life-sustaining component of air. Survival time without oxygen is estimated to be about 3 minutes.

2. Oxygen deficiency is often very difficult to recognize. In cold regions, an oxygen deficient state commonly occurs in cold injuries, altitude changes, and the presence of foreign gases in the air.

a. Cold injuries. Both freezing and nonfreezing injuries indicate either a systemic or localized oxygen deficiency.

b. Elevated altitudes have a reduced oxygen content. (See "Altitude Sickness," which can occur both in mountain operations and in aircraft.)

c. Foreign gases. The most common are carbon dioxide or carbon monoxide; they are usually the result of an inadequate ventilation system.

B. Shelter. Considered as anything that protects the body, the specific shelters considered for cold regions consist of clothing, footwear, sleeping bags, structural shelters, and fire. In cold regions, the ultimate goal of any shelter is maintenance of body temperature. The body operates at an optimum temperature of about 99° F and functions at peak efficiency only within a narrow temperature range of 12 degrees F.

1. Clothing. In cold regions, man must clothe himself to survive. Clothing acts as insulation, preventing body heat from escaping.

a. Clothing standards

(1) It must be protective, comfortable, easy to clean, and durable.

(2) It must be so designed to be worn according to the "layering principle," that is, adaptable to changing weather or operational conditions.

(3) A standard number of layers cannot be prescribed for universal wear, but the standard principles of use must be followed.

(a) Excessive layers should be removed as necessary, such as increased work activity.

(b) Clothing should be loose enough to permit air circulation, thus providing insulation.

(c) Issue sizes should allow for shrinkage.

(d) Clothing should not constrict the wrists and ankles, yet should ensure protection from cold.

(e) A universal rule for wearing cold region clothing is to keep comfortably cool at all times. It is better to underdress, if clothing is worn properly, than to overdress.

b. NOTE: The following C-O-L-D memory device applies to cold region clothing.

(1) Clean clothing

(2) Overheating must be avoided

(3) Loose and layered wearing

(4) Dry clothing

2. Footwear. Feet are more vulnerable to cold than are other parts of the body, because they get wet easily, both from external causes and perspiration. Footwear is considered shelter in close proximity to the body. Regardless of the kind of footwear issued, certain principles of wear minimize the occurrence of cold-induced injuries.

a. Clean the feet and dry them as often as possible.

b. Keep extra socks next to the skin of the abdomen to keep them warm and dry.

c. Socks and boots must be spacious enough to allow toes to move easily. If several pairs of socks are worn, each additional pair should be one size larger than the previous pair.

d. Lace boots securely but not so tight as to constrict.

e. Remove boots when sleeping.

f. Exercise feet periodically to maintain adequate circulation. In cold regions this can consist of either dynamic or isometric exercises.

3. Sleeping bag. This is a shelter composed of two layers of relatively weatherproof fabric separated by insulating material. Much of the body's heat is retained in the bag, even when outside temperature drops. Sleeping bags serve as emergency shelters, shelters for sleep and rest, and prevent cold injuries or complications in cold region casualties. To derive maximum benefit from a sleeping bag, follow these principles:

a. Care and maintenance

(1) Keep the bag clean, dry, aired, and free from rips and tears.

(2) Dry a wet bag as soon and as quickly as possible.

(3) Never put damp or wet clothing in the bag.

(4) Do not eat or smoke while in the bag.

(5) Avoid drinking in the bag, except water from a canteen during the night to prevent dehydration.

(6) To insulate sleeping bags from the ground when in use, place them on air mattresses, pads, or improvised materials, but NEVER on a metal surface.

b. Use

(1) Sleeping bags should be large enough for personnel to move freely during sleep.

(2) Personnel should sleep bare or, if necessary, with minimal clothing to prevent overheating and subsequent sweating.

(3) Extra clothing can be used for additional insulation under the sleeping bag, especially under shoulders and hips.

(4) Dressing and undressing should be done inside the bag to assist in conserving body heat.

(5) When necessary, sleeping bags can be used for buddy warming.

(6) Rest and sleep

(a) Rest is vital to continue muscle function. Without adequate rest, fatigue and exhaustion quickly set in.

(b) Sleep is the best form of rest. To carry out routine deployment activities, a man should have a minimum of 6 hours of steady sleep. This is best accomplished in a comfortable, quiet, safe, and adequately ventilated shelter with recommended temperature 4° to 10° C. Adequate ventilation ensures safety. Freezing rarely occurs during sleep in a sleeping bag that is properly manufactured, maintained, and used.

4. Structural shelters. Without shelter, human beings can survive only within a narrow temperature range. Structural shelters can be made from anything which protects the body from the elements. Although many efficient shelters need little external heat to maintain body warmth, in cold climates some form of heat is needed for comfort.

a. Three general categories

(1) Permanent structures, such as barracks

(2) Temporary or movable structures, such as buildings towed on sleds and tents

(3) Emergency or improvised structures, such as leantos and snow houses

b. Basic requirements of an effective shelter

(1) Heat conservation

(a) Recommended day temperature is 18° to 19° C.

(b) Recommended night temperatures is 4° to 10° C.

(c) These recommended temperatures:

1 Conserve fuel

2 Support humidification

3 Reduce sweating

4 Provide environmental controls that encourage acclimatization

(2) Adequate ventilation. This can be accomplished by placement of adequate holes and pipes.

(3) Humidification

(a) Proper humidification reduces the incidence of upper respiratory conditions.

(b) Humidification can be maintained by controlling heating temperatures and keeping a container of water, ice, or snow on the cooking stove.

(4) Vestibule to help keep out wind and cold

(5) Safety

(a) All structures must have two exits.

(b) The shelter must be marked externally to identify it following blizzards, snowdrifts, etc.

(c) Shelter entrances should point 90° to the prevailing wind line to safeguard against snowdrift blockage.

(d) Good housekeeping and sanitation standards must be enforced to ensure health and environmental safety, as well as good morale.

5. Fire and warmth. Controlled fire is necessary for survival in the cold to provide warmth, to cook, to melt and/or purify water, to dry clothing, to signal, and to boost morale. Uncontrolled fire can kill or destroy. In cold regions uncontrolled fire is one of the greatest threats to survival.

a. Firecraft. Fire building requires basic knowledge of why a fire burns and which fuels are more efficient. These are principles to follow:

(1) Fires should only be as large as the task requires. Several small fires provide more warmth than one large one.

(2) Cold region stoves should be USED AS DIRECTED. DO NOT use substitute fuels.

b. Fire safety. The following safeguards will assist in providing a fire-safe environment:

(1) Indoctrination of all personnel in the use and maintenance of fire fighting equipment

(2) Maintenance of current fire bills

(a) Assignment of scheduled fire safety patrols

(b) Frequent fire drills

(c) Safety inspections to identify:

1 Overloaded electrical wiring

2 Unlabeled combustibles

3 Improperly stored combustibles

4 Any potential safety hazard

C. Water. Survival reports place water, thirst, and dehydration among the most important survival problems. Thirst can be ignored to a great extent by purposeful activity. Dehydration, however, can render a person helpless in a short time. Water is essential to the body's chemical balance, with intake and output of liquids necessary for life processes and normal functions of vital organs. In addition to physiological purposes, water is used for hygiene, sanitation, and food preparation.

1. Requirements

a. The average person needs about 2 quarts each day to maintain normal body functions and efficiency.

(1) Lower intake causes gradual dehydration and diminished capability and proficiency.

(2) Dehydration not only increases the probability of cold injury incidence, but also contributes to constipation, headache, and hemorrhoids.

(3) Coffee and tea have a dehydrating effect on the body.

(4) Drinking water inaccessibility or inconvenience contributes to a condition of inadequate fluid intake among unsupervised personnel.

b. In cold regions, the thirst mechanism does not function as acutely as in hot environments. Perspiration, respiration, and urination are automatic processes that remove water from the body. There is little that can be done about automatic water losses, but it must be replaced.

2. Sources

a. In regions of severe cold, fresh water sources are a constant problem. Because of the limited and often questionable sources of raw, usable water, all water must be purified by boiling or chlorination.

b. Ice and snow

(1) NEVER use "yellow" snow or ice as a water source. It is contaminated.

(2) Use of unmelted ice or snow for fluid intake will, over a long period of time, cause swelling and severe pain in the oral cavity.

(3) The best method for using ice or snow is to keep a large container filled with either on a cooking stove in a shelter. This has three advantages:

(a) It provides a usable, potable water supply.

(b) The melting process provides humidification.

(c) The humidification helps maintain a stable environmental temperature.

3. Conservation. Water supply limitations dictate prudent use of water. Water used in cooking meats and vegetables can be drunk or used for soups. It is also a good source of vitamins and minerals.

4. Hygiene and sanitation. In cold weather operations, each individual is responsible for taking care of his body, clothing, and personal equipment, as well as maintaining his own health and protecting the health of others. Good hygiene and sanitation can be practiced even when the water supply is limited. These practices are paramount disease prevention measures.

a. Mouth care. Clean and floss teeth daily.

b. Skin care

(1) Limit general bathing to once a week.

(2) Wash armpits, crotch, and feet more than once a week; daily, if possible.

(3) General skin care should include frequent application of protective creams to counteract the extreme skin drying effect of cold air. Lips should be continuously protected with ChapStick, etc.

c. Foot care. Keep feet clean, dry, and warm at all times.

(1) Change socks frequently. All personnel must carry at least one extra pair of socks.

(2) If necessary, clean feet with socks that have been worn and are being changed.

(3) Dry damp or wet socks by placing them under the shirt next to the abdomen.

d. General sanitation. Standard sanitary procedures for food handling work well in cold climates; however, housekeeping practices and waste disposal require special considerations.

(1) Living quarters must be kept tidy and swept daily. An untidy camp not only attracts undesirable insects and animals, but also is a fire hazard.

(2) Waste materials must be promptly and thoroughly removed from living areas to control the spread of endemic infections and communicable diseases, and for esthetic reasons.

(3) Waste disposal areas must be located a safe distance from and lower than drinking water sources.

(4) All waste must be either mechanically or chemically treated.

(5) Elimination. Although less obvious than respiration, elimination is a top priority basic need. Patterns of irregular or postponed bowel movements are predisposing factors for such problems as headache and constipation. Toilet facilities should be convenient and allow some degree of comfort while being used. Hands must be washed after elimination.

D. Food. The human body can be compared to a constantly running furnace; to run efficiently, it must always maintain a certain temperature. The food we eat is our fuel; it burns into heat to maintain our normal body temperature. Except under primitive trail conditions, well clothed, sheltered, and trained men use little more food in cold than in moderate climates.

1. Requirements

a. Some increased caloric intake may be required as a result of the energy expenditure of donning and doffing extra clothing and from the weight of the clothing.

b. An increase in fat and protein intake is recommended because of their heat production potential.

(1) Fats are desirable and well tolerated.

(2) Fats give a diet its staying quality.

(3) Protein in its own digestion and oxidation increases body metabolism and thus heat.

c. Hot meals should be eaten as frequently as possible.

d. Vitamins are essential to maintaining health in normal climates. Because of additional physiological stress on the body in cold climates, essential vitamins must be accessible to all personnel.

2. Sources and sanitation

a. Natural food sources may be used to add variety.

(1) Know which vegetative food sources are safe to eat and which are toxic.

(2) Game food sources must be thoroughly cooked, because most wild game is worm-infested. Some wild animal organs are toxic to humans (e.g., polar bear liver). Personnel must know which game is safe for human consumption.

b. Low temperatures inhibit the spontaneous growth of many disease-producing organisms seen in other regions.

c. Standard procedures for food handling and sanitation work well in cold environments.

III. Psychological needs

A. Psychological needs can be roughly divided into two categories: one for maintenance and one for actualization. For pragmatic reasons, only psychological maintenance needs are discussed in relation to cold region operations.

B. Psychological maintenance needs

1. Safety/security. Although safety has been classified under physiological needs, there is a psychological component that must be considered.

a. Safety means the need to experience the absence of threat or danger, e.g., to be able to go to sleep without the fear of freezing to death.

b. Environmental safety contributes to a sense of security--first group, then personal security.

2. Personal security. Establishing a sense of personal security assists in development of response patterns that enhance psychological stress adaptation in cold regions. Some psychological stress factors to anticipate are:

a. Isolation. This feeling may result from storms, desolated areas, dismal locations, and seclusion.

b. Frustration and limitation on activities result from the burden of increased numbers of clothing articles, awkward and clumsy movements, and subsequent increased levels of fatigue and exhaustion.

c. Close living quarters

d. Limited social activities

e. Limited input from outside (operations) sources, especially during long and isolated operations.

f. Depression resulting from boredom or lack of "action"

3. Self-preservation. This survival attitude is nearly 100% mental, because the mind controls the body. Assuming that a positive mental attitude is essential for survival, this attitude can be broken down into two aspects:

a. The will to live

b. Problem-solving ability. This ability programs an individual to act rationally in life-threatening or life-maintenance situations.

IV. Miscellaneous needs. Prior to World War II, people were beginning to understand that the use of men and equipment in cold regions was quite different from that normally encountered in the rest of the world. Supplies, equipment, and vehicles need to be winterized to various degrees. Engines are difficult to start in cold weather. Steel becomes brittle and breaks. Rubber becomes hard, shatters, and breaks. Batteries freeze and lubricants don't flow. Human flesh sticks to metal door handles, gasoline cans, tools, etc. Ordinary equipment does not move across the tundra, in deep snow, over sea-ice, etc. Numerous equipment and transportation problems occur; these must be considered when operations are to take place on land, sea, or air, or a combination of any of the three.

A. Injuries from foreign bodies are best prevented by an awareness of those factors which commonly become cold injury agents.

1. Direct metal contact with bare skin/tissue

a. Watches, rings, braces, and eyeglass frames have a potential for localized cold concentration and subsequent contact injury sites.

b. Dental fillings and metal clips on partial plates are possible temperature-sensitive areas that may contribute to discomfort and potential tissue injury.

2. Direct fuel/liquid contact with skin

a. Direct contact with gasoline and other fuels in extremely low temperatures will induce immediate frostbite.

(1) Gloves should be worn when handling fuels.

(2) Unless absolutely necessary, fuel should not be siphoned by mouth.

b. Cold wet objects adhere to bare skin on contact.

(1) Removing the object usually also removes a layer of skin.

(2) Applying warm water or liquid to the area is the recommended way to remove the object gradually.

3. Direct contact of heat-producing objects with skin

a. Use of uncontrolled heating devices such as hot water bottles and such sources as stoves can cause burn injuries of various degrees.

b. If such forms of heat sources must be used, constant observation and inspection of body contact surfaces must be made.

c. Therapeutic water immersion temperatures must be limited to 105° F.

B. First aid equipment and supplies

1. Requirement criteria

a. Determination of quantities and kinds of first aid equipment and supplies must be made according to the type, length, and numbers of personnel involved in each specific cold weather deployment.

b. Routine supplies and equipment must be adequate to handle various kinds of traumatic conditions, as well as environmental changes.

2. Medical material support recommendations

a. Insulated medical bag - to prevent cold soaking of lifesaving equipment and medications

b. Low reading thermometer - to detect and monitor core temperatures for diagnosis and treatment of hypothermia

c. Tape which does not become brittle or lose adhesive properties when cold soaked

d. Analgesics - nonsedating, nondepressing, and nonhypothermogenic; potent enough to relieve pain in the walking injured without rendering them litter cases

e. Medical vest - to be worn under the parka, warmed by body heat for carrying and preserving vital liquid medications

f. Intravenous administration supplies - cold-resistant containers, tubing, and needles that can be used without aid of gravity

g. Splints - cold-resistant devices made from nonconducting materials to eliminate risk of additional cold injuries

h. Heated medical chest - an easily hand-carried, temperature-controlled container to allow storage of liquid medications.

i. Portable circulating heated water bath - for rapid rewarming of a frozen extremity prior to arrival at a definitive treatment facility

AREA IV. DISTURBANCES DUE TO COLD

CHILBLAIN

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of chilblain as a potential or actual cold weather injury, and institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe chilblain by definition, etiology, contributing factors, and physiological responses.

2. Describe the preventive measures employed as a prophylaxis against chilblain.

3. Describe the signs, symptoms, and findings commonly associated with chilblain.

4. Describe the recommended treatment for the management of chilblain.

5. Describe the prognosis of chilblain as sequelae, complications, and residual effects.

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Abstracted from:
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Stoffel RC: Emergency Preparedness Today. 1976.
US Naval Flight Surgeon's Manual. 1968.

Courses

Environmental Factors in Cold Injury. PI 73-430-705-1 (Programmed Instruction)

Low Temperature Sanitation and Cold Weather Medicine, NAVEDTRA 10997-C. (Correspondence Course)

LECTURE OUTLINE

I. Introduction. Chilblain - a localized reaction of the hands, feet and/or ears resulting from intermittent exposure to temperatures above freezing, accompanied by high humidity. It occurs after repeated or prolonged exposure of bare skin to the elements. Severity depends on temperature, wind, and exposure frequency. The condition demonstrates both an acute and chronic effect. It is also called pernio or erythema pernio. Chilblain is classified as a nonfreezing injury.

II. Prevention

A. Avoid repeated, prolonged exposure

B. Protect obvious exposure areas with adequate clothing

III. Symptoms

A. Acute exposure - initial pallor and blanching. On rewarming, the skin is red, swollen, hot, tender, and itchy.

B. Between exposure and reexposure - skin is red, rough, and cool.

C. Chronic reactivation - skin may present an immersion injury-like effect with blistering, ulcerations, and/or hemorrhagic lesions

IV. Treatment

A. Limit and/or avoid continued exposure

B. Warm gradually at room temperature

C. Itch may be relieved by application of a bland soothing ointment

D. Severe cases with blister formation

1. Keep injured part dry

2. Protect blisters with dry dressing

3. Avoid infection

4. Whirlpool and physiotherapy treatment may be indicated.

E. DO NOT RUB, MASSAGE, OR APPLY DIRECT HEAT OR ICE.

V. Prognosis

A. From a military operations point of view, chilblain is a cold injury which is not considered significantly limiting or disabling.

B. An episode of chilblain often creates a sensitizing condition for recurrence on repeated exposures.

IMMERSION FOOT

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of immersion foot as a potential or actual cold weather injury, and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe immersion foot by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against immersion foot.

3. Describe the signs, symptoms, and findings commonly associated with immersion foot.

4. Describe the recommended treatment for the management of immersion foot.

5. Describe the prognosis of immersion foot as sequelae, complications, and residual effects.

INSTRUCTIONAL MATERIALS

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Stoffel RC: Emergency Preparedness Today. 1976.
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Visual Aids

Arctic Survival, A-2549, 16 mm, color, sound, part I, 1973.

Immersion Foot, H-A-PMB 625, 16 mm, B&W, sound, 22 min, 1966.

Prevention of Cold Injury, TF 8-4879, 16 mm, color, sound, 26 min, 1975.

Trench Foot, MN 3726-F, 16 mm, color, sound, 11 min, 1945.

LECTURE OUTLINE

I. Introduction. Immersion foot - a tissue injury of the feet resulting from prolonged exposure to wet cold at temperatures above freezing. Tissue response results from prolonged action of cold moisture or water on the skin combined with circulatory disturbances due to cold and inactivity, causing venous stasis and general body chilling. The condition presents itself in both an ischemic and hyperemic stage. It is also called trench foot, bomb shelter foot, and water bite. Cases of immersion hand have been reported. Immersion foot is classified as a nonfreezing injury.

II. Prevention. Because the early stages are not painful, personnel must be constantly alert to conditions that influence the development of immersion tissue injuries.

A. Feet should be checked frequently during wet cold operations.

B. Feet should be kept warm and dry by wearing protective footgear.

C. Footwear should not be constricting.

D. Footwear should be cleaned and dried at every opportunity.

E. After getting wet, feet should be dried as soon as possible. They can be warmed with the hands. Foot powder or water repellent agent should be applied and dry socks put on.

F. In the field, extra pairs of dry socks should be carried next to the abdomen and under the shirt. Wet socks can be dried by placing them next to the abdomen and under the shirt.

G. If it is necessary to wear wet socks and footwear for any length of time, the feet should be exercised at regular intervals by wiggling the toes and bending the ankles.

III. Symptoms

A. Ischemic stage - a condition of a deficiency of blood in a part due to constriction or obstruction of the blood vessels.

1. Area is cold, swollen, waxy and mottled with cyanotic burgundy to blue splotches.

2. Area is resilient to palpation.

3. Skin becomes numb and anesthetic.

4. Deep musculoskeletal sensation is usually lost.

5. Feet are stiff and walking is difficult.

B. Hyperemic stage - a condition of an excess of blood in a part due to local or general relaxation of the blood vessels.

1. Area is red, hot, and swollen.

2. Blister formation is common.

3. Constant throbbing pain and burning sensation are experienced.

4. Paresthesia is aggravated by heat and relieved by cold.

IV. Treatment

A. Initial

1. Remove wet footwear, gently wash and dry feet, and expose to air. (A circulating fan is often used. If exposing the feet to cool air, keep the rest of the body warm.)

2. Personnel should be kept off their feet as much as possible. Bed rest is recommended, if feasible.

3. Affected part should be elevated.

4. Area MUST NOT be massaged, moistened, immersed in water, or rapidly rewarmed.

5. Area should be protected from additional trauma or secondary infection.

B. Blister or ulcer formation

1. Blisters should NOT be ruptured.

2. Blisters and ulcers should be kept clean and dry. NO ointments should be applied. If a protective dressing is necessary, a dry, sterile, fluffy dressing should be loosely applied.

3. Affected area should be exposed to air as much as possible and protected by a cradle and surgically clean linen.

4. Analgesics should be administered to relieve pain.

5. Antibiotics should NOT be used in the absence of a confirmed infectious process.

6. Medications can be used to reduce severe edema.

7. Vitamin B complex therapy is recommended.

8. Whirlpool therapy is considered the most useful modality for optimal healing and rehabilitation.

9. Tetanus booster should be prophylactically administered.

V. Prognosis

A. Minimal to moderate cases - recovery in hours to months with few sequelae

B. "Recovered" cases often present late complications of edema, deep stabbing pain, cold sensitivity, chronic infection, causalgia, hyperhydrosis, and a Raynaud's-like phenomenon.

C. Secondary complications of moderate to severe cases are thrombophlebitis, infection, gangrene, and subsequent amputation.

DEHYDRATION

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of dehydration as a potential or actual cold weather injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe dehydration by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against dehydration.

3. Describe the signs, symptoms, and findings commonly associated with dehydration.

4. Describe the recommended treatment for the management of dehydration.

5. Describe the prognosis of dehydration as sequelae, complications, and residual effects.

INSTRUCTIONAL MATERIALS

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Manulas/Pamphlets

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Abstracted from:
Hedblom EE: Polar Manual, 4th ed. 1965.
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US Naval Flight Surgeon's Manual. 1968.

LECTURE OUTLINE

I. Introduction. "To dehydrate" means "to remove water from." In a medical concept, dehydration refers to a condition that results from an excessive loss of body water, either from too little intake or too much output, or a combination of both. The long term maintenance of the water economy of the body depends on the intake of water. Under normal conditions this is easily regulated by the "thirst mechanism." (In severe cold environments, however, the thirst mechanism is not a dependable alarm system.) Water is taken into the body through the mouth and absorbed from the gastrointestinal tract. It is lost from the body through the skin, lungs, gastrointestinal tract, and the kidneys. Increased water loss from respiratory evaporation contributes to loss of heat produced by metabolism. Rate of loss varies with the dryness of the air and the rate of ventilation. Water loss from the lungs is pure water. Water loss from the skin is hypotonic. Water loss from the kidneys is a combination of waste materials and free water; this loss is generally kept at a minimum when a total body water deficit is present. This accounts for the appearance of orange urine in cases of dehydration.

When considering body water balance in cold regions, the phenomenon of cold diuresis deserves mention. Urine output increases on exposure to cold. This phenomenon has been extensively studied, and researchers have posed several reasons for the stimulation of this mechanism. Regardless of the etiology, the increased diuretic effect during cold exposure is important in considering the implications of dehydration as related to the incidence of cold injuries.

II. Prevention

A. Personnel must be properly trained on the need to drink at least 2 quarts of water a day (not including coffee).

B. Fluid intake should be increased at the first sign of changes in the color of the urine, i.e., darker yellow.

C. Avoid dehydrating foods and fluids.

III. Symptoms

A. Body water deficiency of 1:5% body weight

1. Increased pulse
2. Anorexia - nausea
3. Dark urine - constipation
4. Irritability - fatigue - sleepiness
5. Thirst (may not be too noticeable in cold weather)

B. Body water deficiency of 6:10% body weight

1. Headache, dizziness
2. Labored breathing
3. Tingling in extremities
4. Absence of salivation
5. Inability to walk
6. Cyanosis

C. Body water deficiency of 11:20% body weight

1. Swollen tongue - inability to swallow
2. Dim vision - deafness
3. Shriveled, numb skin
4. Painful urination
5. Delirium

IV. Treatment

A. Mild cases - fluid replacement by oral intake (electrolyte loss can be somewhat replaced by Gatorade)

B. More severe cases - cardiac status, serum electrolytes, and pH must be evaluated before massive intravenous therapy is instituted. Avoid cardiac overload.

C. Victim should be kept warm and provided with plenty of rest.

V. Prognosis

A. Early detection and treatment should result in no disabling sequelae.

B. Undetected and untreated cases are prime candidates for developing severe cold injuries such as hypothermia and frostbite. Mildly dehydrated personnel become careless, listless, and are unwilling and/or unable to maintain good hygienic and preventive measures.

HYPOTHERMIA

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of hypothermia as a potential or actual cold weather injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe hypothermia by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against hypothermia.

3. Describe the signs, symptoms, and findings commonly associated with hypothermia.

4. Describe the recommended treatment for the management of hypothermia.

5. Describe the prognosis of hypothermia as sequelae, complications, and residual effects.

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Visual Aids

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Cold Can Kill, MB 12645, Naval Air Systems Command, 16 mm, color, sound, 29 min, 1972.

Prevention of Cold Injury, TF 8-4879, 16 mm, color, sound, 26 min, 1975.

LECTURE OUTLINE

I. Introduction. Hypothermia - the destructive influences of cold on the human body fall into two categories: local or general hypothermia (cooling or freezing). Theoretically, local hypothermia refers to cold injuries that affect tissue in specific areas of the body. Frostbite and immersion foot are examples of localized exposure. General hypothermia is an injury to the entire body, either by immersion or exposure.
When considering hypothermia as a cold injury, it is usually termed accidental hypothermia. This is a general body cooling to a core temperature of 94° F or below. The metabolism of food to produce heat and work for normal body functions requires a core temperature of at least 98° F. As the core temperature drops below 98° F, homoiothermic control becomes unstable and eventually completely lost. The accidental lowering of the body temperature is usually the result of cold wind, moisture, and/or cold water immersion. The latter condition is responsible for what is called immersion hypothermia. Hypothermia is also called advanced cold exposure. Accidental hypothermia is often referred to as chronic, dry cold hypothermia, whereas immersion hypothermia is sometimes called acute, wet cold hypothermia.

II. Prevention

A. All hands should be trained to interpret environmental factors as they relate to the incidence of cold injury, especially the effect of:

1. Wind chill

2. Cold water immersion

B. All hands must be well indoctrinated in cold physiology, especially the effects of:

1. Diminished food, water, and oxygen supplies on the metabolic activity of body tissue

2. Poor circulation

3. Poor physical condition

4. Fatigue and inactivity (sleeping)

5. Severe injuries and concomitant wounds

C. A "buddy system" should be established to observe warning signs of pending hypothermia, e.g., fatigue, disinterest in food and water intake.

D. Appropriate kinds, sizes, and fitting of protective clothing should be supplied.

E. Systematic supervision of clothing discipline should be established.

F. Warm food and fluids should be consumed as frequently as possible without necessarily increasing recommended daily caloric intake.

G. Elements that inhibit normal circulation should be avoided:

1. Tight, constricting clothing

2. Smoking and alcoholic intake

3. Excessive coffee intake

4. Inactivity

5. Vasoconstricting medications

H. All hands should be trained in the factors influencing body heat production, conservation, and loss in both dry and wet cold conditions.

I. Adequate shelter and food MUST be provided.

J. In cold water immersion, all measures to keep the head and neck dry should be taken.

III. Symptoms (confusion to coma)

A. The most useful yardstick in identifying a condition of hypothermia is the determination of the core temperature. Clinically speaking, only core temperatures are relevant. To obtain an accurate core temperature reading, a special rectal probe or long, low-reading rectal thermometer is needed. If neither of these is available, the core temperature can be roughly estimated thus:

1. Above 95° F. Victim is conscious, alert, and may have vigorous shivering.

2. 90° - 95° F. Victim is conscious with mild to moderate clouding of mental facilities; shivering is present but diminished.

3. 86° - 90° F. Victim has severe clouding of consciousness or may be unconscious; shivering is replaced by muscular rigidity.

4. Below 86° F. Victim is unconscious with diminished respirations.

5. Below 80° F. Victim has barely detectable or nondetectable respirations.

(DOT/USCG - COMDTINST 16135.1A)

B. Vital signs alterations

1. Blood pressure is lower than normal; systolic reading frequently below 100.

2. Pulse is slow and irregular, often difficult to palpate in the extremities.

3. Respirations increase during early stages. As core temperature falls below 92° F, respiratory rate gradually diminishes. At low core temperatures, respirations are very slow and labored.

C. Level of consciousness

1. Poor coordination - repeated stumbling, poor control of arms and legs

2. Careless attitude, decreased attention span, dazed, memory lapses

3. Drowsiness, blurred speech, confusion

4. Weakness, slowing pace, unable to maintain muscle movement

5. Disoriented, possible hallucinations

6. Collapse, unconsciousness

D. Shivering is increasingly vigorous and uncontrollable near core temperature of 95° F, but steadily diminishes as temperature decreases. Between 86° - 90° F it is replaced by muscular rigidity.

E. General appearance. Victim is pale and the skin is very cold to the touch.

F. Pupils begin to dilate at core temperature near 92° F and are fully dilated and poorly reactive to light at around 86° F.

G. Decreased urinary output or condensation

IV. Treatment. Field first aid

A. Prevent further heat loss by any method possible.

1. Remove wet clothing.

2. Loosen or remove constricting clothing.

3. Move casualty to warm shelter.

B. Warm casualty by whatever methods are available; do not overheat or burn.

1. Place hot wet towels, blankets, water bottles, etc., on the head, neck, back of the neck, trunk, axilla, groin, and stomach.

2. Wrap casualty in blanket, sleeping bag, etc.

3. Apply body warmth by direct contact with body of nonaffected person; they can be wrapped in the same blanket, etc.

C. Administer emergency CPR, as required.

D. Give nothing by mouth. Ensure patent airway. Watch for and remove excessive secretions or vomitus in airway.

E. Monitor vital signs carefully. Watch for and treat shock.

F. Keep casualty flat on back with head flat, except in head injuries.

G. Keep casualty quiet; move him as little as possible.

H. First aid should be administered to concomitant injuries.

I. Do NOT massage casualty.

J. Evacuate to medical facility as soon as possible.

V. Treatment. Medical

A. Prevent further heat loss in any way possible, e.g., remove wet clothing, move to shelter, etc.

B. Administer life support measures, as necessary:

1. Unconscious, not breathing

a. Mouth-to-mouth resuscitation followed by administration of warmed O_2 through resuscitation bag

b. Closed cardiac massage, if in arrest

(1) Immediate electrocardiogram to determine cardiac status

(2) Defibrillate if ventricular fibrillation is present

2. Unconscious, breathing

a. Administer warm, humidified O_2

b. Cautiously, begin rapid rewarming by the most effective method available. Immersion in a warm water bath at a temperature of approximately 105^{o} F is the most effective. Immersion should continue until core temperature is 95^{o} F, or the patient stops shivering.

3. Conscious

a. Cautiously, begin rapid rewarming by immersion, as above.

b. Administer warm oral fluids, as tolerated.

C. Start an intravenous infusion as soon as possible to facilitate treatment of fluid and electrolyte problems, and also to provide a "mainline" for use in case of life-threatening developments.

1. Fluid and electrolyte replacement therapy should be calculated following:

a. Cardiac status evaluation by ECG

b. Blood pH and electrolytes

2. Acute dehydration has been treated successfully in some cases by using intravenous glucose or low molecular weight dextran as blood volume expanders and for metabolic support.

D. Insert indwelling urinary catheter to monitor output.

E. Keep victim in a warm comfortable environment.

F. Until physiologically stabilized, victim should restrict movements only to those that are necessary.

G. Treat concomitant injuries or wounds as soon as possible.

H. Monitor victim carefully EVEN AFTER all systems appear stabilized. Medical personnel should be alert to the development of post immersion hypothermia "afterdrop" or "afterfall," as it is also called. Afterdrop is a paradoxical fall in core temperature following removal from cold water immersion situations which required little or no initial rewarming therapy.

V. Prognosis

A. Any case of hypothermia can lead to death. The determining variables are the temperature of exposure, the length of exposure, and the availability of equipment for adequate treatment.

B. Immersion hypothermia victims who have been unable to keep their heads and necks dry have reportedly died from cerebral hemorrhage (Dachau experiments).

C. Many survivors of untreated immersion hypothermia die as a result of unnoticed and untreated afterdrop.

D. Properly treated casualties of a single episode of hypothermia can recover without any disabling sequelae.

E. Hypothermia casualties in the field are often also afflicted with other cold injuries, such as frostbite and immersion foot. Prognosis in these cases is directly related to the prognosis of the injuries as single entities.

F. After the acute phase of hypothermia has been adequately stabilized, personnel should be observed for secondary complications of pulmonary infections and acute renal failure.

G. Other complications consist of pancreatitis and disseminated intravascular coagulation.

FROSTBITE

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of frostbite as a potential or actual cold injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe frostbite by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against frostbite.

3. Describe the signs, symptoms, and findings commonly associated with frostbite.

4. Describe the recommended treatment for the management of frostbite.

5. Describe the prognosis of frostbite as sequelae, complications, and residual effects.

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Arctic Survival, A-2549, 16 mm, color, sound, part I, 1973.

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Prevention of Cold Injury, TF 8-4879, 16 mm, color, sound, 26 min, 1975.

LECTURE OUTLINE

I. Introduction. Frostbite - a graded tissue injury resulting from exposure to low environmental temperatures, especially dry, cold, below freezing temperatures. The extent of injury depends primarily on the temperature and the length of exposure. The injury is the result of the freezing of intracellular and extracellular fluid which mechanically disrupts and can destroy the cell membrane.

   A. Superficial frostbite is tissue damage resulting from exposure to low temperatures, involving only the skin and/or immediate tissue beneath it. It is manifested as simple erythema, transient anesthesia, and some superficial bullae.

   B. Deep frostbite is tissue damage resulting from exposure to extremely low temperatures, involving not only the skin and subcutaneous tissue, but also deep layers extending to the bone. It is manifested by persistent ischemia, livid cyanosis, severe edema, formation of large blisters, and secondary thrombosis.

      NOTE: Identification of superficial and deep frostbite may be covert prior to rewarming. To differentiate between freezing and nonfreezing injuries may be diagnostically difficult early after rewarming. Frostbite is a common injury of the face, hands, and feet. It is also called congelation and is classified as a freezing injury.

II. Prevention

   A. All hands should be trained to interpret meteorological data as these influence cold injury.

   B. A "buddy system" should be established to observe for a condition of sudden blanching on the face or ears of a companion.

   C. Any sudden blanching or tingling of the face, ears, feet, and hands should be warmed immediately.

      1. Nose, ears, cheeks, and forehead can be warmed by holding a warm hand over the area.

      2. Hands and fingers can be warmed by placing them in the armpits, against the abdomen, or between the thighs.

      3. Feet and toes can be warmed by placing them in the armpits or against the abdomen of a companion.

D. A sudden cessation of cold discomfort, followed by a pleasant feeling of warmth, is a sign of incipient frostbite. Immediate removal from cold exposure at this time will prevent the development of a cold injury.

E. Clothing should be adequate and worn according to the layering principle. Avoid constriction around wrists, ankles, and the waist.

F. Face, extremities, feet, and hands should be exercised periodically to detect areas of numbness and to improve circulation.

G. Cold metals or liquids should NOT be touched with the bare skin.

H. Avoid the following which influence occurrence of cold injury:

1. Smoking
2. Alcohol intake
3. Excessive coffee drinking
4. Excessive fatigue
5. Improper or inadequate eating habits
6. Excessive activity
7. Unnecessary medications

I. All personnel should drink 2 to 3 quarts of water every day.

III. Symptoms

A. General symptoms

1. Uncomfortable sensation of coldness, followed by numbness and skin anesthesia.
2. Tingling, stinging, aching sensation may be present.
3. Skin first turns red, then pale or waxy white.

B. Superficial frostbite

1. Prethaw

a. Waxy white color (some yellowish-white spots)

b. Skin is cold, frosty, crisp, and resilient.

c. Skin may be freely movable over joints and facial bones.

2. Thaw/postthaw

a. In severe cases blisters develop beneath the outer layer of the skin in about 24 hours. These slowly dry up and become hard and black.

b. Generalized edema of the area subsides if the patient is restricted to bed rest.

c. Throbbing, aching, burning pain persists for several weeks.

d. As edema subsides, the skin peels, remaining red and tender. Cold sensitivity is present and hyperhydrosis continues for some time.

C. Deep frostbite

1. Prethaw

a. Translucent, waxy, pallid, yellowish color

b. Painless

c. Skin is solid or wooden to palpation, but never brittle.

d. Skin is NOT movable over joints or bony prominences.

2. Thaw/postthaw

a. Some aching, throbbing pain often followed by a period of paresthesia and anesthesia

b. Large blisters develop in about 3 days.

c. Affected area is extremely edematous for about a month, accompanied by limitation of movement.

d. After about a month, the blisters blacken and slough off, leaving a thin, red, sensitive layer of new skin.

e. Itching and hyperhydrosis persist for more than 6 months after the injury.

f. Cases not rapidly rewarmed DO NOT become red and blistered after thawing.

(1) Affected area has lifeless gray color and remains cold.

(2) If blisters occur, they appear along the line of demarcation between healthy and frostbitten tissue.

g. Eventually, the tip of the injured area becomes black, dry, and shriveled. The damaged area may progress in one of two ways:

(1) Tissue becomes DRY, black, shriveled, and mummified up to the beginning of healthy tissue. There is no pain or intense swelling.

(2) Tissue becomes WET, soft, inflamed, and usually infected. There is pain and intense swelling.

IV. Treatment

A. Essentially the system approach used for treating superficial and deep frostbite is the same, since differential diagnosis in the initial stages is often difficult. Regardless of the degree of injury, the treatment modality is based on two major principles:

1. Conservative treatment protocol

2. Prevention of infection

B. Field first aid

1. The first priority of treatment consists of treating immediate life-threatening or severe trauma conditions, such as systemic hypothermia, shock, open wounds, fractures, etc.
(For management, see section covering specific problem.)

2. Minor cases of superficial frostbite require little treatment.

   a. Noses, ears, cheeks, fingers, and toes can be rewarmed by body heat.

   b. Personnel should be relieved of their duties long enough to rewarm in sheltered areas.

3. More involved frozen injuries should NOT be thawed in the field.

   a. Personnel with frozen extremities are mobile enough to be independent.

   b. Once thawing has occurred, personnel must be considered medically dependent and litter cases, especially if the injury is a lower extremity.

   c. Thawing in the field creates a potentially hazardous condition for refreezing, which has an overall negative prognosis.

   d. Personnel should receive medical facility care as quickly as possible.

4. If thawing has occurred in the field, follow this protocol:

   a. Move the casualty to a heated shelter.

   b. Loosen or remove all constricting clothing from around the frozen area.

   c. Protect the frozen area from additional cold exposure and sources of trauma.

   d. Treat personnel as litter casualties.

   e. Attempt to maintain and/or restore core temperature by using protective coverings, hot drinks, etc.

   f. Evacuate the casualty to a medical facility as quickly as possible.

5. Frostbite injuries must NOT be massaged, rubbed or packed with snow, covered with ointments, dressed tightly, or warmed with uncontrollable heat sources, such as open fires, engine exhausts, etc. Blisters should NOT be ruptured.

C. Medical management

1. Rapid rewarming is the specific therapy which minimizes tissue loss and complicating sequelae.

   a. Thaw in a CAREFULLY CONTROLLED water bath at a temperature of 105° F (40° C) until digital tips turn pink or burgundy red (approximately 20 minutes to 1 hour). This is best accomplished in a whirlpool or tub bath. A surgical soap or Ivory soap should be added to the bath.

   b. If a bath is not available, thaw with warm wet packs at temperatures ranging between 100° and 112° F (37.7° to 44.5° C).

   c. Administer sedatives and/or analgesics, as the thawing process is extremely painful.

   d. The RAPID THAWING method should NOT be used if the area has been previously thawed.

2. After thawing protocol

   a. Treat area by the open method.

   b. Use sterile pledgets of lamb's wool or cotton to relieve interdigit pressure and maceration. Avoid digital vessel compression.

   c. Keep extremities on sterile sheets and protect with cradles to avoid pressure and trauma to the injured area.

   d. Personnel MUST be kept on bed rest.

   e. Give two whirlpool baths a day for 20 minutes each time, with water temperature between 90° and 95° F. Use a surgical soap in the whirlpool solution.

      (1) Debride tissue manually ONLY to remove loose tissue not removed in the whirlpool.

      (2) Remove eschars only when they are dry and cause joint motion limitation.

f. Surgical amputation should be performed only when sufficient time has elapsed and tissue death with mummification is absolutely, clinically obvious or in cases of life-endangering systemic reactions.

g. Encourage personnel to do Buerger's exercises at least four times a day.

h. Administer analgesics and tranquilizers prudently, as the chronic and slow recovery process of this condition encourages drug dependence.

i. Provide casualties--and encourage them to consume--a well balanced diet, high in carbohydrates and protein.

j. Provide vitamin and mineral supplements, as deemed clinically necessary.

k. Ensure that surroundings are conducive to patients' rest and quiet but at the same time minimize prolonged periods of boredom.

3. Progressive care of frostbite using steroids, anticoagulants, enzymes, plasma expanders, fasciotomy, sympathectomy, and adrenergic blocking agents has been reported, and all have been effective in some management cases. Use of any or all of these modalities must be determined by the attending physician in light of the individual pathophysiological process of the injured.

4. Discourage smoking in all cold injuries involving vascular integrity.

5. Administer tetanus toxoid boosters as soon as possible following injury.

V. Prognosis

A. The prognosis of freezing injuries is initially determined by the history of the occurrence of the injury. The severity of the injury is directly determined by the length of exposure and the degree of temperature responsible for the injury. The course of treatment and expected results are based on the history of the freeze. Frostbite injuries are seen by medical personnel following one of three kinds of freezing history:

1. An initial freeze

2. A freeze-thaw course

3. A freeze-thaw-refreeze course

B. Initial freeze injuries can be thawed by two methods:

1. Spontaneous rewarming (as in a warm room) - a hazardous method which can precipitate the development of a deep injury in an initially superficial one

2. Rapid rewarming is the most efficient and prognostically effective. Minimal complications and/or disabilities can be anticipated.

C. Freeze-thaw injuries should NOT be rapidly rewarmed.

1. These injuries present variable prognostic measurements depending on the method of thaw used. Several methods of rewarming have been used when medical facilities were not available. These methods include:

a. Dry heat thawing (such as a wood fire). The undesirable results of this method are thermal heat burns and additional vascular damage.

b. Ice/snow thawing. This is a slow spontaneous method which can stimulate the development of a deep injury from a superficial injury.

2. Freeze-thaw injuries are commonly found among military personnel who have not been properly trained in cold environmental physiology and the relationship to preventive and first aid measures.

D. Freeze-thaw-refreeze injuries

1. These are commonly found among military personnel engaged on long-range mountain and ski operations.

2. Like freeze-thaw injuries, these generally result from improper indoctrination of personnel in cold environmental physiology and first aid measures.

3. The prognosis of freeze-thaw-refreeze injuries is the poorest, resulting in the development of grave insult to the afflicted tissue.

E. The major complications of frostbite injuries are infection, gangrene, and subsequent amputation.

F. Residual effects of frostbite are cold sensitivity, tissue scarring with or without contractures, and mobility impairment, especially following amputation.

G. A direct relationship exists between tissue exposure time and the amount of residual tissue damage that occurs.

ALTITUDE SICKNESS

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of altitude sickness as a potential or actual cold weather injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe altitude sickness by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against altitude sickness.

3. Describe the signs, symptoms, and findings commonly associated with altitude sickness.

4. Describe the recommended treatment for the management of altitude sickness.

5. Describe the prognosis of altitude sickness as sequelae, complications, and residual effects.

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Simplified Cold Physiology.
Abstracted from:
Hedblom EE: Polar Manual, 4th ed. 1965.
Stoffel RC: Emergency Preparedness Today. 1976.
US Naval Flight Surgeon's Manual. 1968

LECTURE OUTLINE

I. Introduction. Altitude sickness - the effects of altitude result from the thinning-out of the air as one ascends to higher elevations. As altitude increases, barometric pressure decreases progressively. Barometric pressure determines the partial pressure of oxygen in the air, which in turn determines how much oxygen will reach the alveoli of the lungs and how much oxygen will be transferred to the body for eventual release to body tissues.
Altitude sickness is a syndrome caused by hypoxia. Its severity is increased proportionately to the speed of ascent and the height of elevation. The effect of cold on body tissues is increased in high altitudes. This syndrome presents an acute and chronic phase. The acute phase consists of the body's response on immediate exposure. The chronic phase is a result of the body's response following prolonged exposure. Altitude sickness is also called mountain sickness and cerebral mountain sickness.

II. Prevention

A. The most effective preventive measure is a 10- to 14-day well planned acclimatization program in which altitude ascent is gradually progressive.

B. When gradual acclimatization is not feasible, follow these procedures:

1. Avoid heavy exercise during the first 3 to 4 days at high altitudes.

2. Eliminate smoking.

3. Ensure adequate hydration to compensate for blood volume depletion. NOTE: The thirst mechanism is reduced in acute mountain sickness.

4. Some experts have found that mild diuretics (Diamox) are effective in preventing altitude sickness, if given before or during ascent.

III. Symptoms - start about 4 hours after reaching high altitude

A. Hypoxia. The body has a complex set of physiological responses to hypoxia. A large amount of body fluids shift from the blood into the extravascular space, resulting in too little fluid in the circulatory system and too much fluid elsewhere. Both conditions create problems, namely dehydration (hemoconcentration) and edema (pulmonary and cerebral). Symptoms of both conditions can be anticipated.

B. Headache, nausea, vomiting, loss of appetite

C. Lightheadedness, memory and judgmental impairment

D. Fatigue, irritability, sleeplessness

E. Shortness of breath - rapid or intermittent respirations

F. Poor night vision

G. Euphoria or depression

H. Hyperventilation. Following strenuous exercises in the cold at high altitudes, symptoms include asthmatic-like respirations and expectoration of frank blood; this condition is often referred to as frostbite of the lungs, which is not a true freezing injury.

IV. Treatment. Minor cases are best treated symptomatically. Complicated cases which involve high altitude pulmonary edema (HAPE) and cerebral edema require sophisticated medical management and monitoring. Treatment for the latter will not be discussed in this outline.

A. If possible, evacuate to a low altitude immediately.

B. Prescribe rest.

C. Administer O_2 (do not hyperventilate).

D. Increase Fluid intake.

E. Diuretics (furosemide) have been found of value in early stages.

F. Steroid therapy (dexamethasone) has been found of some value, especially in cases with cerebral edema.

V. Prognosis

A. Mild uncomplicated cases recover with little or no sequelae. An episode of mountain sickness does appear to influence a recurrence on additional exposures.

B. Personnel experiencing episodes of altitude sickness are highly prone to developing serious cold injuries.

C. Complicated cases of mountain sickness may progress to any of the following life-threatening conditions:

1. Pulmonary edema

2. Cerebral edema

3. Cerebral thrombosis → stroke

CARBON MONOXIDE POISONING

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of carbon monoxide poisoning as a potential or actual cold weather injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe carbon monoxide poisoning by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against carbon monoxide poisoning.

3. Describe the signs, symptoms, and findings commonly associated with carbon monoxide poisoning.

4. Describe the recommended treatment for the management of carbon monoxide poisoning.

5. Describe the prognosis of carbon monoxide poisoning as sequelae, complications, and residual effects.

INSTRUCTIONAL MATERIALS

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Simplified Cold Physiology.
Abstracted from:
Hedblom EE: Polar Manual, 4th ed. 1965.
Stoffel RC: Emergency Preparedness Today. 1976.
US Naval Flight Surgeon's Manual. 1968.

LECTURE OUTLINE

I. Introduction. Carbon monoxide poisoning is a form of anoxia that results from the inhalation of the gas. CO is absorbed through the lungs and combines with hemoglobin to produce hypoxia. The development of carboxyhemoglobin interferes with the oxygen-liberating function of hemoglobin, thus causing tissue anoxia. Since CO combines with the red cells about 200 times more quickly than O_2, carbon monoxide easily displaces any inhaled oxygen. The toxicity of CO increases with altitude.

II. Prevention

A. Since carbon monoxide is a colorless, odorless gas, preventive methods are based on an understanding of environmental hazards created by the production of the gas.

B. The most common sources are engine exhausts and coal stoves. Essentially, it is produced by any combustion process which uses a carbon product as fuel.

C. Ensure adequate ventilation in shelters and vehicles.

D. Do NOT use unvented engines and heaters as heat sources.

E. Use care when cooking over open-flame stoves.

F. Safety measures for sleeping areas:

1. Provide facilities with a CO alarm system.

2. Assign a roving watch.

3. Turn heaters off.

G. It takes a combination of two factors to create a carbon monoxide hazard:

1. Improper burning of fuel

2. Insufficient ventilation

III. Symptoms

A. Headache, throbbing temples

B. Dizziness, dimmed vision, mental confusion

C. Yawning, weariness of exhilaration

D. Nausea, ringing in the ears

E. Bright red color on lips and skin

F. Cardiac throbbing, flutter, or pain

G. Muscle pain, weakness, collapse

H. Unconsciousness and death

I. CO poisoning from leaded fuels presents symptoms of smarting eyes, runny nose, and dry cough.

NOTE: Not all of the above symptoms manifest themselves before the terminal stage is reached.

IV. Treatment

A. Immediately move victim to fresh air.

B. Administer artificial respiration and cardiac massage if respiratory and cardiac arrest are present.

C. When spontaneous respirations are present, administer 100% oxygen. A small percentage of CO_2 may be mixed with the O_2 if hyperventilation is desired.

D. Keep victim warm and quiet at least 8 hours in a well ventilated area. Early exertion precipitates cardiac failure.

E. Anticipate signs and symptoms of shock, and treat accordingly.

F. Do NOT give victims stimulants.

V. Prognosis.

A. Treated properly and early enough, there are no complicating sequelae.

B. Pneumonitis, permanent brain damage, and death are all possible residual effects.

SNOWBLINDNESS

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize the condition of snowblindness as a potential or actual cold weather injury and to institute appropriate preventive and restorative measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Describe snowblindness by definition, etiology, contributing factors, and physiological body responses.

2. Describe the preventive measures employed as a prophylaxis against snowblindness.

3. Describe the signs, symptoms, and findings commonly associated with snowblindness.

4. Describe the recommended treatment for the management of snowblindness.

5. Describe the prognosis of snowblindness as sequelae, complications, and residual effects.

INSTRUCTIONAL MATERIALS

References

Book

US Naval Flight Surgeon's Manual. Washington DC, US Government Printing Office, 1968, pp 519-520.

Manuals/Pamphlets

US Army: FM 21-10, Field Hygiene and Sanitation. Washington DC, 1970, p 86.

US Army: TC 21-3, Soldier's Handbook for Individual Operations and Survival in Cold Weather Areas. Washington DC, 1974, p 32.

US Navy: Hedblom EE. Polar Manual, 4th ed. Bethesda MD, NMS-NNMC, 1965, p 61.

LECTURE OUTLINE

I. Introduction. Snowblindness is a temporary visual disturbance due to injury of the conjunctiva and the superficial cells of the cornea caused by the ultraviolet rays of the sun reflected by snow or a bright-covered surface. Danger of snowblindness is greatest NOT on a clear, bright day, but rather on a dull, cloudy day or when crystalline snow mist is present (whiteout). There is no warning that damage has been done until symptoms begin to appear from 2 to 12 hours after exposure.

II. Prevention. Like all cold-related injuries, snowblindness is preventable. NO well trained personnel should suffer from this injury!

A. Personnel should be well indoctrinated on the course and prevention of snowblindness.

B. Protective glasses MUST be worn on hazardous days. Extra glasses should be available.

1. Sunglasses should be worn on bright days.

2. Yellow glasses should be worn on overcast days.

C. If glasses are lost, the following improvisations are helpful:

1. Make eye protectors from cardboard cut in the shape of eye glasses with horizontal slits to facilitate seeing.

2. Pull a muffler, stocking cap, etc., over the eyes, using the space between the fabric knit to facilitate seeing.

D. Blackening the lower eyelid and cheeks (like football players) will absorb the sun's rays and stop them from reflecting into the eyes.

E. The objective of all preventive methods is to reduce the amount of light getting through to the eyes.

III. Symptoms

A. Irritating gritty feeling in the eyes

B. SEVERE pain in and over the eyes due to conjunctival irritation

C. Excessive lacrimation

D. A hot, sticky sensation in the eyes

E. Photophobia and blurred vision (objects may appear pink)

F. Headache, probably due to the ultraviolet effect on the retina

G. Depression affecting one's ability to function normally, and extreme dependence on others

IV. Treatment. A single episode of snowblindness, properly treated, lasts from 1 to 5 days.

A. The most effective treatment is rest and darkness.

1. Provide a dark room.

2. Apply a light-proof bandage.

B. If air temperature is above freezing, cold compresses can provide some relief from pain.

C. Severe pain can be treated with a benign analgesic. Occasional analgesic eye medications are indicated.

D. Severe cases may require sedatives or tranquilizers.

E. Cocaine eye preparations must NOT be used, as they have softening effect on the corneal epithelium.

V. Prognosis

A. Minor cases usually recover in about 18 hours.

B. Severe cases may require 3 to 4 days.

C. An episode of snowblindness stimulates the development of recurrence following additional exposure.

AREA V. ACUTE MINOR ILLNESSES AND TRAUMA

UPPER RESPIRATORY DISTURBANCES

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illnesses of upper respiratory disturbances as they occur in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe upper respiratory disturbances as acute minor illnesses in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Upper respiratory disturbances - active, well nourished military personnel in cold regions should not experience any respiratory problems which differ from those experienced in warm regions.

II. Predisposing factors

A. Poor nutritional status

B. Inadequate dressing

1. Overdressing to the point of excessive perspiration

2. Underdressing to the point of constant chilling

C. History of repeated and/or chronic respiratory problems

1. Sinusitis, rhinitis, or bronchitis

2. Cigarette cough

3. Colds

D. Poor sanitary and hygienic habits

E. Excessively dry living environment

III. Prevention

A. Maintain adequate nutritional status.

B. Adhere to the layering principle when dressing. Adjust clothing to activity requirements.

C. Personnel with history of chronic respiratory problems should NOT be selected for cold weather operations. If this is not feasible, these personnel should seek medical assistance at the onset of symptoms.

D. Maintain good sanitary and hygienic habits.

E. Humidify living environment.

IV. Treatment

A. Institute routine symptomatic treatment as early as possible.

1. Force fluids

2. Mild antipyretics for temperature elevation

3. Plenty of rest

B. Isolate as much as possible from nonsymptomatic personnel to prevent spread.

C. Rule out the possibility of serious medical problems (e.g., tuberculosis, pneumonia)

HEADACHE

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illness of headache as it occurs in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe headache as an acute minor illness in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Headache - a common complaint in cold environments. It can be attributed to both psychological and physiological factors.

II. Predisposing factors

  A. Psychological

    1. Boredom resulting from isolation

    2. Tension resulting from close living

  B. Physiological

    1. Constipation resulting from ignoring "nature's call"

2. Sinusitis and dehydration from breathing hot, dry air in shelters.

3. Dehydration from:

   a. Excessive coffee drinking

   b. Cold diuresis

   c. Inadequate fluid intake

4. Inadequate ventilation in living spaces

5. Excessive smoking resulting from boredom

6. Excessive eye strain

III. Prevention

A. Well balanced, regular meals

B. Fluid intake (less coffee) of at least 2 quarts/day

C. Humidified shelters (e.g., container of water on stove)

D. Ventilated shelters

E. Limited smoking and coffee intake (caffeine-free)

F. Avoidance of eye strain from reading, etc.

IV. Treatment

A. Identification and correction of etiological factors

B. Program of activities to minimize boredom and provide an outlet for built-up tension

C. Mild analgesic for symptomatic relief

D. NaCl nose drops for symptomatic relief of dry mucous membranes

E. Mild antihistamine, if indicated by history

F. Constipation, managed by diet and increased fluid intake

G. Rest during acute, severe attacks

H. Rule out the possibility of serious medical problems, as etiological factors (e.g., high blood pressure)

CONSTIPATION

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illness of constipation as it occurs in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe constipation as an acute minor illness in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Constipation - a common complication of dehydration in cold environments, or the result of a decrease in activity, change in dietary patterns, and ignoring "nature's call"

II. Predisposing factors

A. Psychological

1. Compulsive individuals - result of tension from close living

2. Negativistic individuals

3. Laziness

B. Physiological

1. Dehydration is the major contributing factor.

2. Diet - limited fresh fruits, vegetables, and roughage

3. Reduced exercise

III. Prevention

A. Well balanced, regular meals - increase roughage with cereal consumption

B. Fluid intake (less coffee) of at least 2 quarts/day

C. Answer "nature's call" promptly

D. Increase physical activity if job is of a sedentary nature.

IV. Treatment

A. Identify and correct etiological factors

B. Increase roughage in daily diet

C. Increase fluid intake

D. Use mild laxative to initiate regularity pattern

HEMORRHOIDS

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illness of hemorrhoids as it occurs in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe hemorrhoids as an acute minor illness in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Hemorrhoids - a bulging or sagging of rectal and anal veins. In cold regions, hemorrhoids are usually the result of chronic constipation.

II. Predisposing factors

A. Chronic constipation

B. History of bowel irregularity

III. Prevention

A. Maintain regular bowel habits

B. Avoid constipation

IV. Treatment

A. Same as for constipation, if such is the etiology

B. Frequent sitz baths

C. Application of soothing local analgesics (e.g., Tucks, suppositories, ointments)

D. Keep off feet in severe cases (thrombosis)

DIARRHEA

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illness of diarrhea as it occurs in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe diarrhea as an acute minor illness in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Diarrhea - closely associated with gastrointestinal problems in all aspects. In cold regions the possibility of endemic etiology should be considered.

II. Predisposing factors

A. Excessive coffee intake

B. Food intolerance

C. "Diarrheal-type" personalities

D. History of frequent episodes of diarrhea

E. Poor sanitation or hygienic habits

F. Contaminated potable water

III. Prevention

A. Limit coffee intake

B. Adjust diet if food intolerance is a factor

1. Local, native food must be thoroughly washed and cooked before consumption.

2. Assure proper storage of food supplies.

C. Maintain good sanitary and hygienic habits.

D. All drinking and cooking water must be treated by chemicals or boiling prior to use.

E. Maintain active immunization, as available, against endemic diseases (e.g., typhoid).

IV. Treatment

A. If an endemic organism is suspected as the etiological factor, the organism must be identified and specific chemotherapy must be initiated (e.g., typhoid treated with Chloromycetin).

B. Unknown etiology - treat symptomatically with medications such as Lomotil and Kaopectate.

C. If food sensitivity is identified, avoid that specific food product.

D. Arrest severe/frequent diarrhea to avoid complication of dehydration.

1. Assure electrolyte stability with oral juices, broths, bouillon, etc., as tolerated.

2. Severe cases may require intravenous fluid/electrolyte replacement.

E. Rest during acute episodes

F. Rule out the possibility of serious medical problems such as amebiasis or colitis.

GASTROINTESTINAL DISTURBANCES

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illnesses of gastrointestinal disturbances as they occur in cold regions.

Instructional Objective

At the end of this unit, the student will be able to describe gastrointestinal disturbances as acute minor illnesses in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MH: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Gastrointestinal disturbances - as a minor illness in cold regions, these can be of viral, bacterial, or parasitic origin, or the result of changes in dietary habits.

II. Predisposing factors

A. Natural intolerance of dietary changes, especially fat intolerance

B. "Stomach type" personalities

C. History of frequent bouts of gastrointestinal problems

D. Poor sanitation or hygienic habits

III. Prevention

A. Limit fat intake if it is the etiological factor.

B. Maintain good sanitary and hygienic habits:

1. Wash hands frequently.

2. Wash all food products well before eating or cooking.

IV. Treatment

A. Viral - self-limiting course; treat symptomatically. Encourage large amounts of fluids, broth, etc.

B. Bacterial - if organism is identified, treat with antibacterial drug of choice

C. Parasitic - if organism is identified, treat wtih anthelmintic drug of choice

D. Stress:

1. Antacids for temporary relief

2. Remove from stress situation, if possible (reassign within unit)

E. Prevent dehydration, regardless of etiological factor

F. Rest

G. Rule out serious medical problems (e.g., ulcers, appendicitis)

GENITOURINARY DISTURBANCES

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize and institute basic treatment measures for the acute minor illnesses of genitourinary disturbances as they occur in cold regions.

Instructional Objective

At the end of this unit the student will be able to describe genitourinary disturbances as acute minor illnesses in cold regions, specific predisposing factors, common preventive measures, and limited treatment.

INSTRUCTIONAL MATERIALS

Books

Holvey DN (ed): The Merck Manual, 12th ed. Rahway NJ, Merck Sharp & Dohme Research Laboratories, 1972.

Krupp MA, Chatton MJ: Current Medical Diagnosis and Treatment. Los Altos CA, Lange Medical Publishers, 1976.

LECTURE OUTLINE

I. Introduction. Genitourinary disturbances - the major problems encountered in cold regions consist of urinary tract infections and genital rashes.

II. Predisposing factors

A. History of stones and/or infections

B. Inadequate fluid intake

C. Poor sanitary and hygienic practices

III. Prevention

A. Personnel with a history of chronic genitourinary problems should not be assigned to long term cold region deployments.

B. Maintenance of adequate fluid intake

C. Good sanitary and hygienic practices. Genital area should be kept clean and dry at all times.

IV. Treatment

A. If urine is dark orange, fluid intake must be increased.

B. Bladder infections can be treated with appropriate urinary tract antibiotics and antiseptics.

C. Genital rashes and lesions must be cleansed and dried frequently. Antibiotic and/or antipruritic ointments or powders may be applied prudently.

D. Rule out the possibility of serious medical problems, e.g., kidney infections, stones, VD.

TRAUMATIC PROBLEMS

OBJECTIVES

Terminal Objective

At the end of this unit, the student will be able to recognize traumatic problems as shock, fractures, minor cuts, abrasions, and sprains as they are specifically influenced in cold regions, and to institute appropriate emergency first aid measures.

Instructional Objectives

At the end of this unit, the student will be able to:

1. Define shock and describe its incidence, symptoms, and treatment in cold environments.

2. Describe the incidence, symptoms, and treatment of fractures in cold environments.

3. Describe the first aid priority given to cuts, abrasions, and sprains in cold environments.

INSTRUCTIONAL MATERIALS

References

Books

Hedblom EE: Polar Manual, 4th ed. Bethesda MD, NMS-NNMC, 1965, pp 79-80.

Stoffel RC: Emergency Preparedness Today. State of Washington, Department of Emergency Services, 1976, pp 69-71.

Manuals/Pamphlets

US Navy: Standard First Aid Training Course, NAVEDTRA 10081-C. Washington DC, US Government Printing Office, 1978.

LECTURE OUTLINE

I. Introduction. First aid:

A. The fundamentals of first aid are the same, whether the temperature is -30° F or 80° F, but prevention and treatment measures in severe cold have to be modified to meet the additional hazard of freezing temperatures.

B. In cold weather, casualties should be given first aid and protected from shock and the development of specific cold injuries. Injuries considered more than minor must be evacuated to a medical facility as soon as possible. Casualties requiring evacuation should not be left unattended.

II. Specific conditions

A. Shock. Injured personnel in cold regions go into shock more quickly and more profoundly than in temperate regions. Because of this, the development of hypothermia and freezing injuries are enhanced.

1. Symptoms

a. Apprehension

b. Sweating, cold, clammy skin

c. Pallor

d. Rapid, faint pulse

e. Thirst

2. Treatment

a. Keep casualty warm.

b. Keep casualty's head lower than feet, EXCEPT in head injuries

c. Loosen clothing at neck, chest, and waist, but do NOT permit heat loss.

d. If conscious, administer warm liquids by mouth. Do NOT give alcohol.

e. Move casualty as little as possible, but transport to a warm medical facility as quickly as possible.

f. Maintain respiratory integrity.

B. Fractures - common in cold environments, especially in the presence of ice and snow

1. Symptoms

a. Pain, joint tenderness

b. Edema

c. Misalignment (not always present)

2. Treatment

a. Treat for shock.

b. Immobilize extremity. Ensure that splints, wraps, etc., do NOT reduce circulation; this hastens development of frostbite. Do not use pneumatic splints.

c. Conscious patients may be given mild analgesics for pain.

d. Keep injured warm. Protect extremity from cold.

e. Dress bleeding, open wounds immediately.

(1) Body loses heat rapidly around open wounds.

(2) Increased bleeding precipitates shock.

(3) Open wounds freeze easily.

C. Give immediate first aid care to minor cuts, abrasions, sprains, etc.

D. Treat all painful or disabling injuries as though complicated by shock.

GLOSSARY

This glossary has been developed for those persons who have little knowledge and experience in cold weather operations. An attempt has been made to limit definitions to their cold specific meanings. To be of immediate assistance to nonmedical personnel, clinical terminology has been made as simple as possible. Undoubtedly words that should have been included have been overlooked and definitions that appear clear to the writer will be vague to some readers. Many of these deficiencies will be corrected through the use of medical and standard dictionaries for explanation of meanings. It should be noted that entries not available in either standard or medical dictionaries have been abstracted from the literature published by recognized experts of cold environment subjects.

ablation net loss of snow or ice by melting, sublimation, evaporation, or wind action during a specific period of time. The opposite of accumulation.

accidental hypothermia uncontrolled, abnormally low body temperature due to exposure to cold. Abnormal lowering of the body temperature which cools to the point of heat depletion and subsequent depression of the normal body temperature. Also called chronic, dry cold hypothermia.

acclimation Alterations related to changes in a lifetime.

acclimatization the usual physiological adjustment that an individual organism exhibits to a change in its immediate environment. Changes in the responses of the organism produced by continued alterations in the environment.

accumulation net gain of snow or ice during a specific period of time. The opposite of ablation.

Acosta's disease mountain sickness (named after a Jesuit father who first described it after his travels in Peru in 1590). See acute mountain sickness, moutain anemia, and altitude sickness.

active layer annually thawed layer. The layer of ground that thaws in the summer and freezes again in the winter (equivalent to seasonally frozen ground).

acute moutain sickness a condition resulting from difficulty in adjusting to reduced partial pressures of oxygen at high altitudes, especially above 11,000 feet. Symptoms include oliguria, dyspnea, changes in blood pressure and pulse rate, headache, and neurological

disorders. See Acosta's disease, mountain anemia, and altitude sickness.

adaptation a change in structure, function, or form that produces a better adjustment to an environment.

advanced cold exposure see accidental hypothermia.

afterdrop a paradoxical fall in core temperature following removal from cold water immersion situations which required little or no initial rewarming therapy. Also called afterfall.

ahkio boat-like sled used for pulling squad equipment over snow.

altitude sickness the effects of oxygen deficiency in the blood and tissues developed in rarefield air at high altitudes with symptoms of headache, lassitude, palpitation, nosebleed, and nausea. See acute mountain sickness, mountain anemia, and Acosta's disease.

ambient temperature the degree of sensible heat or cold of the surrounding air.

anabolism any constructive process by which simple substances are converted by living cells into more complex compounds, especially living matter.

anoxia total deprivation of oxygen.

anxiety a state of being uneasy, or worried about what may happen.

basal metabolic rate (B.M.R.) the quantity of energy used by an organism at rest; amount of heat produced by human organism 14 to 18 hours after eating and when at rest in a warm environment for 30 to 60 minutes, but not asleep. It is measured by rate (basal metabolic rate) at which heat is given off, and is expressed in calories per hour, per square meter of skin surface.

biological death ceasing of all spontaneous, vital body functions. Technology can support vital functions past biological death.

bitter cold a subjective evaluation as to the type of cold.

blizzard a severe weather condition characterized by low termperatures and strong winds bearing great amounts of snow. The National Weather Service has established the following criteria: Winds 28 knots (32 mph) or higher, low termperatures and sufficient snow to reduce visibility to less than 152 meters (500 ft).

body heat conservation preserving or protecting the heat given off by the body; keeping body warmth or heat energy at a safe level for survival, and therefore, maintaining the body's core termperature.

body's enemies anything that physically and mentally brings harm to the human body:

- mind - through panic, fear, imagination, attitude.
- injury - may seriously affect mobility, coordination, and ability for self-help.
- temperature - must be maintained within a very narrow 12-degree range for efficient rational behavior.
- disease or infection - constant threat, normally held in check by body defense mechanism.

body temperature a measure of the body's heat content or storage.

bomb shelter foot see immersion foot.

breakup period of spring thaw during which the ground surface is excessively wet and soft, and ice is disappearing from streams and lakes. Duration of the breakup period varies usually from 1-6 weeks depending on regional and local climatic conditions. The breakup season causes difficult movement problems.

buddy system an arrangement in which two individuals are paired to provide mutual assistance or protection.

calorigenic producing heat or energy; increasing heat or energy production; increasing the consumption of oxygen.

calorophthalgia burning eye pain caused by exposure of the unprotected eyes to extremely bright reflections from ice, snow, buildings, or cloud-covered skies; a symptom of snowblindness.

cardiopulmonary resuscitation (C.P.R.) act of reviving someone by artificial respiration and closed cardiac message.

catabolism any destructive process by which complex substances are converted by living cells into more simple compounds.

chilblain a recurrent localized itching, swelling, and painful erythema on the fingers, toes, or ears, produced by mild frostbite. A cold injury which causes lesions, usually on the hands, caused by prolonged or repeated exposure to mild, humid cold. Also called erythema pernio and pernio.

chinook warm dry wind which raises the temperature and melts snow from the ground.

clinical death a state in which there is a total absence of brain activity. An irreversible condition in spite of sophisticated medical technology.

clo a unit for measuring insulation.

cold allergy a condition manifested by local and systemic reactions, mediated by histamine, which is released from mast cells and basophils as a result of exposure to cold.

cold diuresis an increase of urine output on exposure to the cold. Increased diuretic effect during cold exposure.

cold injury an inclusive term applied to injuries resulting from cold. The most common are frostbite, immersion foot, and chilblain.

cold sensitivity the state of abnormal responsiveness to cold stimulation.

cold shock a condition of acute peripheral circulatory failure due to derangement of circulatory control due to exposure to extreme cold.

comfort zone that environmental condition that contributes to neither sweating nor shivering.

conduction body heat loss by skin touching anything colder than body temperature.

congelation see frostbite.

convection body heat loss by the transmission of heat to a passing flow of air or water. Convection loss is a result of blood flow to the body's periphery.

core temperature the degree of sensible heat or cold at the most central point of the body.

cornice an overhanging formation of snow, usually formed on a mountain ridge, at the crest of a gully and/or a steep slope.

crack a fissure or crevice in a rock or ice formation.

crevasse a fissure or rift in glaciers, shelf ice, or other land-ice formations, caused by thermal changes in the ice or by motion of the ice over underlying obstacles. A deep crack or fissure in the ice of a glacier.

cyclonic storms a storm system of winds, often violent, with abundant precipitation and a usual diameter of 80 to 14,000 km (50 to 900 miles). It is characterized by winds rotating about a calm center of low atmospheric pressures, often at speeds as high as 80 to 120 kts. These storms are called hurricanes in the West Indies. The winds rotate clockwise in the Southern Hemisphere and counterclockwise in the Northern Hemisphere.

dehydration the condition that results from excessive loss of body water. Can be intravascular, intracellular or both.

disposal bags heavy waterproof bags into which personnel defecate, used because it is sometimes impractical to prepare pit latrines in swampy or frozen ground.

dry cold condition that occurs when temperatures are below freezing. The ground is usually hard and snow dry.

dry heat thawing a rewarming method in situations lacking medical facilities by using such things as wood fire. The undesirable results of this method are thermal heat burns and additional vascular and tissue damage.

dry snow zone zone on icecap where maximum temperatures are not high enough to cause melting.

earth hummock see frost mound.

earth mound see frost mound.

edging placing or holding a ski at a different angle than that of the supporting snow.

energy technically, the ability to do work. Foodstuffs produce chemical energy necessary for body functions, but the body can store only about a normal day's supply in immediately available or usable form. At onset of survival situations, a limited amount of energy will be readily available.

energy balance energy to maintain the body's delicate temperature balance and energy to move and do work comes from the same energy tank. We must maintain a balance of consumption pursuant with existing conditions.

energy maintenance preserving the capacity to operate or work. Power to produce motion, to overcome resistance, and to effect physical change.

eschar necrotic tissue, usually black in color, in the process of separating from the viable portions of the body due to cold injury, thermal burn, corrosive application, and gangrene.

evaporation the natural way the body cools itself by removing moisture from the skin. Body water, as perspiration, is dried up or vaporized to cause heat loss.

exhaustion great fatigue or weariness. A state in which you are physically incapable of continuing without extensive rest, sleep, or help from others.

exposure being subjected to severe environmental elements.

fall line the imaginary line running directly down a slope in relation to the skier. The line of gravity pull or of straight descent down which a ball of snow would roll.

fast ice all types of ice, broken or unbroken, attached to the shore, beached, stranded, or attached to the bottom in shoal water.

fatigue physical or mental exhaustion; strain and reduction of efficiency.

fear something that occurs at unconscious level, and creates feelings of uneasiness, general discomfort, worry, or depression.

freezing injuries cold injuries that involve the formation of ice crystals in the intracellular and extracellular fluid.

freezeup period during which the ground surface freezes and ice cover forms on streams and lakes. This period varies from 1 to 3 months depending on regional and local climatic conditions. Maintaining mobility during this period becomes easier as the period progresses.

frostbite a cold injury caused by freezing of the body tissues. Also called congelation.

frostbite (deep) damage resulting from exposure to extremely low temperatures, involving not only the skin and subcutaneous tissue but also deeper tissues, sometimes leading to gangrene and loss of affected parts. It is marked by persistent ischemia, secondary thrombosis, and livid cyanosis.

frostbite (superficial) damage resulting from exposure to low temperatures, involving only the skin or extending to the tissue immediately beneath it. It may be manifested as simple erythema, transient anesthesia, and superficial bullae.

frost boil accumulation of excess water and mud in subsurface materials during spring thawing. It usually weakens the surface and may break through, causing a quagmire.

frostline see frost table.

frost mound a localized uplift of land surface caused by frost heaving or by ground water pressure. Also called earth mound, earth hummock, pals, pingo, or pingok.

frostnip an early sign of impending frostbite. Symptoms of frostnip are redness, swelling, burning, tingling, and no blisters. Frostnip is reversible.

frost table more or less irregular surface that represents the depth of penetration of the winter frost in the seasonal frozen ground. It may or may not coincide with the permafrost table.

fuel tablets concentrated chemical fuel dispensed in tablet form for heating rations, or starting wood fires.

general hypothermia lowering of body core temperature to abnormal level. See hypothermia.

glacier any field or stream of ice of land origin. It may be either active or stagnant.

goose bumps a roughness of the skin produced by erection of its papillae and usually caused by cold or fear. See horripilation.

greyout a phenomenon which occurs over a snow covered surface during twilight or when the sun is close to the horizon. The result is an overall greyness to surroundings causing a loss of depth perception. Greyout is similar to whiteout except that during greyout, the horizon is distinguishable.

habitation the act of changing one's mode of living. The technique of living that occurs when people have become acclimatized.

HAPE high altitude pulmonary edema.

heat exchange heat will be exchanged by conduction between the body and any material in contact with it which is a different temperature.

heat production the making of body warmth. The state of the body that is characterized by elevation of temperature. A form of energy produced by the body, the addition of which causes the body's temperature to rise. It is regulated within the body by both physical and chemical mechanisms.

Hedblom's syndrome a primary myositis and spasm of the diaphragm, with respiratory and referred shoulder pain and spasm of the upper abdominal muscles, caused by upper respiratory tract chilling or infection. It lasts 1 to 2 weeks. Also called acute primary diaphragmitis.

homeostasis tendency to maintain normal, internal stability in an organism by coordinated responses of the organ systems that automatically compensate for environmental changes.

homoiothermy the maintenance of a constant body temperature despite changes in the environmental temperature. Also spelled homeothermy.

horripilation the erection or standing on end of the fine hairs of the skin.

hunting reaction periods of vasoconstriction alternating with periods of vasodilation in a finger or other parts exposed to temperatures below 15° C. Reflex contraction and dilation of vessels producing localized redness.

hyperthermia accidental increase of the body core temperature beyond 37° C. during hot, humid weather conditions.

hypothalamus part of the brain that regulates many basic body functions, as temperature.

hypothermia general lowering of the body temperature due to loss of heat at a rate faster than the body can produce it. Can be therapeutic or destructive.

hypoxia abnormal condition resulting from a decrease in oxygen supplied to body tissue.

icecrete a mixture of sand, gravel, and water poured into forms and frozen. The process is much the same as making concrete except that ice (instead of cement) forms the bonding material.

icefield an extensive sheet of sea ice larger than an ice floe. A large body of glacial ice. A stagnant glacier.

ice fog a type of fog composed of suspended particles of ice, partly ice crystals 20 to 100 microns in diameter. It is formed by introduction of water vapor into clear, calm air of low temperatures. Ice fog normally will be found in the vicinity of populated areas of temperatures of -37° C., or lower, but may be found at temperatures as warm as -6° C. Ice fog increases in frequency with decreasing temperature until it is almost always present at air temperatures of -46° C. in the vicinity of a source of water vapor. Ice fog may form over a body of troops, herd of animals, bivouac areas, motor parks, airfields, convoys, and gun positions during firing.

ice/snow thawing a thawing method in situations lacking medical facilities. A slow, spontaneous method which can stimulate the development of a deep injury from a superficial one.

immersion foot an injury resembling trench foot caused by prolonged immersion of the extremities in water (generally from 23° to 31° C). A painful condition of the foot marked by inflammation and stabbing pain and followed by discoloration, swelling, ulcers, and numbness due to prolonged exposure to moist cold usually without actual freezing.

immersion hypothermia abnormally low body temperature resulting from being submerged in cold water. Loss of body heat into the surrounding water where heat loss exceeds the amount of heat being produced.

improvising to make, provide to do with the materials available or on hand.

insensible perspiration a response that occurs automatically when a minor temperature rise triggers the heat regulatory center. It is called insensible because it is water diffusing through the skin and evaporating before it becomes visible.

inspiratory hydration a process in which the body humidifies inspired air that is extremely dry. In cold, dry regions, it contributes to body water loss.

insulation utilization of materials to reduce body heat loss by convection, evaporation, radiation, or conduction.

isometrics a method of physical exercise in which one set of muscles is briefly tensed in opposition to another set.

layering principle additional insulation attained by trapping dead air in the spaces between successive layers of clothing. Two or more thicknesses of clothing, with intervening airspaces, provide greater insulation than the same thickness of clothing of the same material in a single layer.

local hypothermia cold injuries that affect tissue in specific areas of the body, such as, frostbite and immersion foot.

mental incompetence inability to mentally realize a threat to one's body. Inefficiency in problem solving ability.

mental inefficiency lack of problem solving ability usually precipitated by imbalance in the body's temperature.

metabolism the sum of all physical and chemical processes by which living organized substance is produced and maintained (anabolism), and also the transformation by which energy is made available for the uses of the organism (catabolism).

methods body gains excessive heat

- by walking or lying on hot ground and among hot rocks (conduction);
- the sun's ultra-violet radiation can burn exposed skin and the burn will retard sweating (radiation); and
- heavy exertion in extremely hot environments.

mind

- a person's mind controls any situation.
- the survivor's brain becomes his greatest asset or most dangerous enemy in a survival situation.

mountain anemia a form of mountain sickness. See acute mountain sickness, Acosta's disease, and altitude sickness.

muskeg poorly drained organic terrain which is characteristic of the subarctic, covered with a thick resilient carpet of water-sodden mosses and tussocks, and underlain by a high water table, peat of variable thickness, and often permafrost.

nature's rule survival of the fittest (mental and physical).

necessities of life proper positive mental attitude, air, shelter, rest, water, and food.

nonfreezing injuries cold injuries that do not involve the formation of ice crystals in the intracellular and extracellular fluids.

pack ice any large accumulation of floating ice driven closely together.

pals see frost mound.

panic uncontrolled urge to hurry or run from a situation. Panic is triggered by the mind and imagination under stress.

pemmican concentrated food consisting essentially of dried beef, pounded fine, and mixed with flour, molasses, and suet, used for emergency rations.

permafrost permanently frozen ground. A thickness of soil or other surficial deposit or even a bedrock at a variable depth beneath the surface of the earth in which a temperature below freezing has existed continuously for thousands of years.

pernio see chilblain.

perspiration sweat.

pingo a small low mound of earth or gravel presumably due to frost action. Also called frost mound.

pingok see frost mound.

poling a pushing movement of the arms and body with ski poles against the snow to increase momentum in the glide. Single poling is the use of each pole alternately to obtain this propulsion. Double poling is the use of both poles at the same time.

predetermined ideas false ideas of impressions about situations or problems which could be very detrimental in a survival situation. Example: rub frostbite with snow.

problem solving ability sound judgment based on a thorough understanding of indicators within the body as well as an understanding of the surrounding environment.

quagmire soft, miry wet land that shakes or yields under the foot.

rabbit starvation a sickness, or possibly death, resulting from eating excessively lean meat from an animal that is already skinny, such as a rabbit. Major symptoms are headache and diarrhea, occurring within 3 to 4 days to one week. The decrease of fat intake causes an increase in the desire for food, which increases the severity of the symptoms.

radiation loss of body heat by transfer through rays of energy without direct contact with other materials. The body is like a large radiator, and heats a microenvironment directly surrounding it.

rapid rewarming immersion in a whirlpool or warm water bath at a temperature of approximately 40° C. For hypothermia, immersion should continue until the core temperature is at least 35° C. For frostbite, immersion should continue until digital tips turn pink or burgundy. This is the most efficient and prognostically effective method of rewarming. Minimal complications and/or disabilities can be anticipated.

rest a condition of total physical and/or mental inactivity. The basic factor in recovery from fatigue and also important in resisting further fatigue.

rewarming shock a condition of acute circulatory failure caused by sudden push of cold blood from the peripheral circulation to the body's core due to the effect of applying warmth to the body's shell.

rules of energy conservation

- watch the pace. Balance the load, rate, time period. rest.
- eat high protein energy foods.
- ventilate. Remove a layer of clothing or slow down.
- ration sweat, not water.
- adjust technique of work.

sastruga one of a series of long parallel snow ridges occurring on the open plains and formed by the action of winds. Also spelled zastruga.

sensible perspiration sweat that occurs whenever body temperature continues to increase, causing heat regulatory nerve centers to open the millions of tiny sweat glands which perforate the skin.

shell temperature the degree of sensible heat or cold of the body's external covering or encasement.

shelter anything that covers, protects, or defends from the elements.

shivering involuntary trembling or quivering of the body caused by contraction or twitching of the muscles. A physiologic method of heat production in man and other mammals. The body's automatic defense in combating heat loss. This body function can produce heat equivalent to slow running.

signal a sound, gesture, indication, smoke, or anything that communicates a message.

skijoring troops mounted on skis and towed behind vehicles.

sleep the best method of compensate for fatigue of everyday activities. Nature's most complete form of rest.

slough part of the natural drainage system for either an area or a stream. Water will sometimes back up into this area leaving ponds and temporary streams. Generally, the surface will be muddy and covered with vegetation of all types.

snow anvil see sastruga.

snowblindness inflammation and photophobia caused by exposure of the unprotected eyes to ultraviolet rays reflected from fields of snow and/or ice. Temporary loss of sight due to injury to superficial cells of the cornea caused by ultraviolet rays of the sun reinforced by those reflected by snow.

snow bridge the snowmass that sometimes covers the surface opening of a crevasse.

spontaneous rewarming slow thawing of a frostbite injury taking place without intentionally applying external heat. Thawing that occurs independently when a casualty is removed from severe cold exposure and allowed to thaw without external intervention.

S. T. O. P. rules to follow when lost:

S - stop, calm down, sit down.
T - think of immediate danger, future danger, terrain, available resources.
O - observe everything about the surroundings. What really is the immediate situation?
P - plan activities. Make a plan and carry it out.

survival staying alive or keeping the body alive. Survival is a word applied to any situation which may cause a threat to the body. A person may have to overcome this threat either alone or as part of a group.

survival kit components

- instant body shelter; materials available
- fire making capabilities;
- hot drink preparation capabilities;
- effective means of signaling.

survival priorities

- will to live - depends on you.
- oxygen, or air, for oxidation of food fuel - 3 minutes.
- body shelter from temperature extremes - 3 hours.
- rest - 30 hours.
- water, or liquid, for body chemistry - 3 days.
- food fuel for energy - 3 weeks.

survival psychology the whole-man concept of the body, mind, and spirit preparedness in dealing with survival situations.

sweat increase in heat production by muscle action causes body's automatic regulating processes to try to cool itself by secreting body water; also called perspiration.

thermal equilibrium the body's ability to alter its rate of heat production and heat loss to achieve a state of balance.

thermodynamics the branch of science which deals with heat, energy, and the interconversion of these, and with related problems.

thirst mechanism conditions of the body functioning together to produce the effect or sensation of craving drink, often referred to the mouth and throat. Interpreted as a desire for water. The bodily condition that induces the sensation of thirst.

total metabolic rate the maximum quantity of energy used by an organism. It is expressed in calories per hour per square meter of body surface.

tractor sled train (for movement over snow) a train usually composed of cargo sleds and towed by track laying vehicles.

treeline the upper limit of tree growth in mountainous regions of the northern limit in the Arctic.

trench foot a thermal injury resulting from exposure to cold, short of freezing, in a damp or wet environment. A painful condition of the feet marked by inflammation, swelling, mottled discoloration, burning pain, blisters, and in severe cases, gangrene due to the combined temperature which is cold and wet upon the feet.

tundra a flat or gently rolling area with a muck to rock surface over permafrost and consisting of a low mat of grasses, shrubs, and other plants. This area is found above or north of the treeline.

tussock a tuft or clump of grass or sedge.

water bite foot see immersion foot.

wet cold condition that occurs when temperatures are near freezing and variations in day and night temperatures cause alternate freezing and thawing. These conditions cause the ground to become slushy and muddy.

whiteout a surface weather condition in an arctic area in which no object casts a shadow, the horizon cannot be seen, and only dark objects are discernible, and which is caused by heavy cloud cover over a snow surface so that light coming through the clouds is essentially equal to the light reflected off the snow. Recognition of irregularities in the terrain is very difficult. Fog will sometimes create a similar condition.

williwaw a sudden violent and cold downslope wind, which is common along mountainous coastal areas in the northern latitudes. A willi waw may last several days.

wind chill phenomenon the cooling effect of moving air on a body expressed as the amount of heat lost per unit area per unit time and taking into account both temperature and wind speed. The combined effect of wind and temperature is expressed as an equivalent temperature. This combination is the effective temperature acting on the exposed flesh.

zastruga see sastruga.

ALTITUDE

Karpovich OV, Sinning WE: Physiology of Muscular Activity. Philadelphia, W B Saunders Co, 1971, pp 255-261.

Discusses the effects of high altitude on performance, including acclimatization and the role of oxygen intake/debt in the adaptive process. Applicable to professional audience.

Kleiner JP, Nelson WP: High altitude pulmonary edema. JAMA 234: 491-495, 1975.

Several case reports on HAPE as discussed by Army physicians. Covers predisposing factors, initial and repeated exposure incidents and prevalence. Applicable to professional audience. Nineteen article bibliography.

Lozar M et al: Cold-induced vasodilation and peripheral blood flow under local cold stress in man at altitude. Aviat Space Environ Med: 48(6):497-500, 1977.

Study, using experimental and control group of lowlanders and high altitude natives, of acclimatization responses. Study suggests acclimatization value. Applicable to professional audience. Nineteen article bibliography.

Moyer D: Acclimatization and high altitude medical problems in Antarctica. US Navy Med 67:19-21, 1976.

Brief article discussing mountain sickness as it relates to acclimatization - treatment recommendations included. Applicable to medical/paramedical audiences.

Moyer D: Medical support in Antarctica during operation Deep Freeze. US Navy Med 68:24-25, 1977.

Brief article discussing the reduction in the incidence of acute mountain sickness by using a predeployment acclimatization period. Applicable to medical/paramedical audiences.

ALTITUDE con.

Singh I et al: Acute mountain sickness. N Engl J Med 280:175-134, 1969.

Report of a study of 1925 cases of acute mountain sickness. Clinical symptoms were attributed to hypoxia, pulmonary congestion, increased cerebral blood flow, increased CSF pressure, and cerebral edema. Routine therapy consisted of the use of furosemide. Applicable to professional audience. Forty-four article bibliography.

Sutton JR et al: Pulmonary gas exchange in acute mountain sickness. Aviat Space Environ Med 47(10):1032-1037, 1976.

Study of seven military males airlifted, after 5-day staging, to high altitude. Study suggests pulmonary and cerebral edema develop simultaneously. Applicable to professional audience. Thirty-one article bibliography.

US Army: AR 40-5, Medical Services Preventive Medicine. Washington DC, US Government Printing Office, 1969, pp 4-2 & 4-5.

Very brief/limited discussion of high altitude problems - prevention recommendations. Applicable to medical/paramedical audiences.

US Army: TB Med 288, Medical problems of man at high terrestial elevations. Washington DC, US Government Printing Office, October 15, 1975.

Twenty-one page article discussing the incidence, pathogenesis, clinical description, treatment and prevention of the adverse effects of short term exposure to high altitudes. Applicable to medical/paramedical audiences. Nine article bibliography.

Wilson R: Acute high altitude illness in mountaineers and problems of rescue. Ann Intern Med 78:421-428, 1973.

Several case reports discussing mountain sickness as hypoxia, preretinal hemorrhage, cerebral edema, and their sequelae. Applicable to professional audience. Sixty-nine article bibliography.

DENTAL

Joseph E: Dentistry for the ship surgeon. Brit Med J:679-681, Mar 24, 1956.

Discusses shipboard dental emergencies as supplies and equipment needed, common problems, and treatment techniques. Applicable to medical/paramedical audiences.

Lisney SJW: Dental problems in Antarctica. Brit Dent J 141(3): 91-92, 1976.

Brief article exploring the hypothesis that many health problems in Antarctica are dental in origin. Applicable to medical/paramedical audiences. Twenty-two article bibliography.

DIET

Stefansson V: Pemmican. Mil Surg 95(2):89-98, 1944.

Discusses various kinds of pemmican, its nutritional composition, and value in cold regions. Applicable to universal audience. Author is a well experienced cold weather expert.

Stefansson V: The diets of explorers. Mil Surg 95(1):1-3, 1944.

Discusses the problems of high protein nature of a cold region diet and the value of increased fat intake. Applicable to universal audience.

FROSTBITE/IMMERSION FOOT

Allen AM, Taplin D: Tropical immersion foot. Lancet:1185-1189, Nov 1973.

Generalized clinical survey study citing histopathology/ epidemiology, and recommended treatment. Includes chart comparing clinical course of tropical immersion foot/wet water immersion foot. Applicable to medical/paramedical personnel.

Ballinger WF, Rutherford RB, Zuidema GD: The Management of Trauma. Philadelphia, W B Saunders Co, 1973, pp 706-710.

Survey-type article discussing frostbite as COLD-burn injuries. Applicable to professional audience. Forty-seven article bibliography.

Cave EF, Burke JF, Boyd RJ: Trauma Management. Chicago, Yearbook Medical Publishers Inc, 1974, pp 1163-1167.

A frostbite-specific chapter, briefly mentioning trench foot, chilblains, erythrocyanosis, including symptoms and treatment. Applicable to professional audience. Twelve article bibliography.

Dunning MWF: Gangrene exposure to cold. Brit J Surg 51:883-887, 1964.

Historical resume of extremity injuries induced by cold. Frostbite briefly mentioned. Major emphasis of article is trench and immersion foot. Applicable to universal audience.

Erikson U, Poten B: Arteriograms supplemented by a vasodilator agent in the early assessment of tissue viability in frostbite. Brit J Accid Surg 6(2):150-153, 1974.

Limited case discussion article emphasizing vascular injury and management. Applicable to professional audience. Five article bibliography.

King RC, Parrish JA: Trench-foot in peacetime England. Brit Med J:1099-1102, May 10, 1958.

Detailed case report of 2 incidents of immersion foot among non-military personnel. Both cases terminated in amputation. Applicable to medical/paramedical audience. Twenty-eight article bibliography.

Lapp NL, Juergens JL: Frostbite. Mayo Clin Proc 40:932-948, 1965.

A review of literature on frostbite and summarization of current concepts of pathologic physiology and therapy. Supports rapid rewarming therapy. Applicable to professional audience. Eighty-five article bibliography.

Levine R. Bruning N, and Perlow P. The Cold Weather Catalogue. Garden City, N.Y., Dolphin Books/Doubleday and Co., Inc. 1977.

A 224-page book covering every aspect of living in cold weather from self entertainment to cold injury prevention. Applicable to interested personnel of all levels. ISBN 0-385-13494-0. Purchase price about $7.95.

Maxcy KF, Rosenaus MJ: Preventive Medicine and Public Health. New York, Appleton-Century-Crofts, 1973, pp 837-842.

Concise frostbite/immersion foot article - includes discussion of temperature and humidity to general concomitant disease predispositions - e.g., chronic respiratory problems. Applicable to medical/paramedical audience.

Mills WJ: Frostbite. In: Encyclopedia Britannica, 15th ed., 1974, pp 750-751.

Brief discussion of frostbite which includes cold injury to tissue, predisposing frostbite conditions, recognition, treatment, and preventive measures. Applicable to universal audience. Six article bibliography.

Mills WJ: Frostbite. Northwest Med 65:119-125, 1966.

Discusses the pathophysiology of frostbite and rewarming method of treatment. Emphasizes the conservative approach to treatment with avoidance of infection. Article illustrated. Applicable to medical/paramedical audiences. Forty article bibliography.

Sumner DS et al: Host factors in human frostbite. Mil Med:454-461, June 1974.

Clinical study on environmental/host factors influencing frostbite. Includes detailed statistical data. Applicable to professional audience. Thirteen article bibliography.

Varma RN, Bopari MS: Cold injury as an occupational hazard in the armed forces. Indian J Med Res:1478-1485, Oct 1974.

Statistically oriented, epidemiological analysis of military cold injuries of the INDO-PAK conflict of 1971. Emphasizes environmental and host factors influencing cold injury. Stresses preventive health education. Applicable to medical/paramedical audiences.

HYPOTHERMIA

Andrews CI, Orkin LR: Environmental cold and man. Anesthesiology 25: 549-559, 1964.

An anesthesiologist-oriented article discussing the basic physiological and pathological consequences of body cooling. Applicable to professional audiences. Ninety-three article bibliography.

Bangs C, Hamlet M, Mills W. Help for the victim of hypothermia. Patient Care: 46-68, December 1977.

A detailed article discussing the various current approaches to managing the hypothermia victim. Unique format, includes patient education aid, graphic presentation of hypothermia process, and patient care flow chart. Applicable to professional audience.

Beckman EL, Reeves E: Physiological implications as to survival during immersion in water at 75° F. Aerosp Med:1136-1142, Nov 1966.

Article based on Molnar's study and controlled research of 24 naval personnel in which a table of life expectancy for personnel immersed in water at various temperatures was developed. Applicable to professional audience. Twelve article bibliography.

Beeson PB, McDermott W: Textbook of Medicine. Philadelphia, W B Saunders Co, 1975, pp 65-66.

Very brief article on hypothermia - limited to generalization of key aspects in diagnosis and treatment. Applicable to medical/paramedical audiences for overview information. Nine article bibliography.

Bennett T et al: Physiological and medical aspects of a relay cross-channel swim. J Sports Med Phys Fitness 13:253-265, 1973.

Pre-water immersion training aspects article. Brief discussion concerning various immersion problems and preventive measures utilized. Applicable to general-interest audience. Three article bibliography.

Collis ML, Steinman AM, Chaney RD: Accidental hypothermia: an experimental study of practical rewarming methods. Aviat Space Environ Med 48(7):625-632, 1977.

Five rewarming techniques, appropriate for first aid use, were applied to 9 subjects with 35° C body temperatures. Study supports IRAH as the most effective. Applicable to medical/paramedical audiences. Fifty-one article bibliography.

Golden F: Shipwreck and survival. J Royal Nav Med Serv 60:80-84, 1974.

General interest article with historically oriented description of results of hypothermia without medical treatment. Applicable to medical/paramedical audiences. Thirty-one article bibliography.

Hayward JS, Eckerson JD, Collis ML: Effects of behavioral variables on cooling rate of man in cold water. J Appl Physiol 38(6):1073-1077, 1975.

Controlled study of immersion activity as it relates to heat loss. Introduces the HELP concept. Applicable to professional audience with specialized interests. Eighteen article bibliography.

Hayward JS, Eckerson JD, Collis ML: Thermal balance and survival time prediction of man in cold water. Can J Physiol Pharmacol 53: 21-32, 1975.

Controlled study discussing physical size and thermogenic response to cold water immersion. Heavy with scientific data, graphs, and measurements. Applicable to professional audience with specialized interests. Thirty-seven article bibliography.

Hayward JS, Steinman AM: Accidental hypothermia: an experimental study of inhalation rewarming. Aviat Space Environ Med:1236-1240, Oct 1975.

Literature survey article examining the value of inhalation rewarming in relation to the concept of "after drop." Applicable to professional audience. Thirty-four article bibliography.

Keating WR: Survival in Cold Water. Edinburgh, Blackwell Scientific Publications, 1969.

A one hundred and thirty-one page book discussing the body heat mechanism and the physiological changes occurring during cold water immersion. Includes the effects of age, drugs, habits, and acclimatization on immersion survival. Applicable to professional audience. Three hundred article bibliography.

Molnar GA: Survival of hypothermia by man immersed in the ocean. JAMA 131:1046-1050, 1946.

An analysis, using BUMED data of the recorded times of immersion of shipwrecked survivors, which establishes an immersion tolerance limit. Applicable to professional audience. Thirteen article bibliography.

Pugh LGCE: Accidental hypothermia in walkers, climbers, and campers. Brit Med J 1:123-129, 1966.

Twenty-three brief case histories of hypothermia incidents. Includes a statistical summary of the disease process. Discusses host and

environmental factors. Interesting thesis on the role of subcutaneous fat on incidence of cold injury. Applicable to medical/paramedical audiences. Thirteen article bibliography.

Trunkey DD, Blaisdell FW: Cold injury in a trauma patient. West J Med 125(3):237-240, 1976.

A case presentation discussing the complications of injuries sustained by a fall from a window with a condition of hypothermia. Applicable to professional audience.

US Coast Guard: A pocket guide to cold water survival. Washington DC, US Government Printing Office, 1976.

Brief guide discussing immersion accidents. Emphasis on body heat loss and conservation. Applicable to universal audience.

Zingy W: The management of accidental hypothermia. Can Med Assoc J 96:214-218, 1967.

Outlines the background upon which treatment of hypothermia is based, using a triage echelon criterion. Applicable to medical/paramedical personnel. Seven article bibliography.

GENERAL COLD

Birch CA: Emergencies in Medical Practice. Baltimore, Williams and Wilkins Co, 1976.

Several brief articles, scanty clinical aspects of frostbite, snowblindness, hypothermia in adults/children. Applicable to medical/paramedical audience.

Bowman WD et al: Medical aspects of mountain climbing. Physician Sports Med:52-68, Oct 1976.

Published, round-table discussion by medical and/or medically oriented cold weather experts regarding the benefit of planning, physical conditioning, and good judgement on successful mountain climbing. Applicable to general interest audience. Fourteen article bibliography.

Burton AC, Edholm OG: Man in a Cold Environment. London, Edward Arnold Publishers LTD, 1955.

Thirteen chapter discussion of cold physiology. Highly research-study oriented. Applicable to physiology-specific professional audience. Each chapter is generously referenced. (1955 edition is out of print. Newer editions printed in 1970).

Canadian Forces Headquarters: Basic Cold Weather Training, CFP 302 (2) - Part I, Canada, 1971.

An all-hands manual covering cold weather operations. Total of seven chapters. Chapters 1 (General Introduction), 2 (Personal Clothing and Equipment), and 7 (Cold Weather Injuries and Health Rules) are relevant to medically oriented personnel. Applicable to all-hands.

Davidson AF, Blake WJ: Challenge of the Arctic. J Royal Nav Med Serv 60:17-21, 1974.

Brief article discussing climate, clothing, morale, and survival in the Arctic. Applicable to general interest audience. Single article bibliography.

DOD: Emergency War Surgery (1st US rev, NATO Handbook). Washington DC, US Government Printing Office, 1975.

Brief overview discussion of cold injury and initial management. Limited content. Applicable to medical/paramedical personnel.

GENERAL COLD con.

Doolittle WH: Disturbances due to cold. In: Current Therapy, Conn HF (ed). Philadelphia, W B Saunders Co, 1976, pp 857-862.

Current discussion of frostbite, immersion foot, chilblain, and accidental hypothermia. Major emphasis is treatment. Applicable to medical/paramedical audiences.

Edholm OG, Bacharach AL: The Physiology of Human Survival. New York, Academic Press, 1965.

Text discusses physiology in both extreme heat and cold environments. Specific subjects written by a variety of authors. Applicable to physiology-specific professional audience. Each chapter is generously referenced.

Harrison TR et al: Principles of Internal Medicine. New York, McGraw-Hill Co, 1974, pp 52-54.

Brief article discussing frostbite, immersion foot, and hypothermia as symptoms and treatment. Applicable to professional audience. Eleven article bibliography.

Hedblom EE: Disturbances due to cold. In: Current Therapy, Conn HF (ed). Philadelphia, W B Saunders Co, 1965, pp 691-696.

Discusses chilblains, superficial and deep frostbite, immersion foot, and hypothermia (acute and chronic). Some mention of frostbite of the lungs. Author is a cold weather expert (Polar Manual). Applicable to medical/paramedical audiences.

Hedblom EE: Disturbances due to cold. In: Current Therapy, Conn HF (ed). Philadelphia, W B Saunders, 1972.

Revision of 1965 article. Discussion of "pulmonary chilling" vice "frostbite of the lungs." Applicable to medical/paramedical audiences.

Hedblom EE: Polar Manual, 4th ed. Bethesda Md, USNMS-NNMC, 1965.

Comprehensive book - overview of all aspects of cold weather survival - major stress, prevention. Applicable to universal audience. Three hundred and forty-three article bibliography. (Out of print - contact HSETC - CODE 21, Bethesda Md).

Itoh S: Physiology of Cold-Adapted Man. Sapporo Japan: Buneido Co LTD, 1974.

Report of a ten-year study on AINU population. Discusses various physiological, biochemical, thermoregulatory mechanisms. Applicable to professional audience. Four hundred article bibliography.

Keating WR: Survival in Cold Water. Edinburgh, Blackwell Scientific Publications, 1969.

A one hundred and thirty-one page book discussing the body heat mechanism and the physiological changes occurring during cold water immersion. Includes the effects of age, drugs, habits, and acclimatization in immersion survival. Applicable to professional audience. Three hundred article bibliography.

LeBlanc J: Man in the Cold. Springfield Il, Charles C. Thomas, 1975.

Physiologically oriented discussion of general, metabolic, endocrine, and cardiovascular responses to cold. Devotes two chapters to adaptation. Brief chapter on hypothermia and frostbite. Applicable to professional audience. Some chapters of value for paramedicals. Two hundred and twenty-five article bibliography.

Lugg DJ: Antarctica medicine. Med J Aust 2:335-337, 1975.

Brief historical literature survey regarding health problems in cold climates. Stress of article is importance of medical research in polar medicine. Applicable to general interest audience.

Meehan JP: Individual and racial variations in a vascular response to a cold stimulus. Mil Med 116:330-334, 1955.

Study of three different racial groups on cold exposure response in the fingers. Results support the thesis that race does influence cold adaptation. Applicable to general interest audience. Four article bibliography.

Mills WJ: Disturbances due to cold. In: Current Therapy, Conn HF (ed). Philadelphia, W B Saunders Co, 1968, pp 817-820.

Discusses cold injury as a result of generalized body cooling, or rapid insidious heat loss. Emphasis on hypothermia and frostbite. Applicable to medical/paramedical audience.

Mills WJ: Frostbite and hypothermia. Alaska Med 15(2):26-59, 1973.

Discusses current concepts of both kinds of cold injury including case reports with narratives and colored illustrations. Applicable

to professional audience. Twenty-two article bibliography.

Mills WJ: Out in the Cold. Emerg Med 8(1):134-147, Jan 1976.

Somewhat detailed article discussing hypothermia and frostbite from treatment to prognosis. Applicable to medical/paramedical audiences.

Parker JF, West VR: Bioastronautics Data Book, 2nd ed. Washington DC, US Government Printing Office, 1973.

Twenty chapter book similar to the Flight Surgeon's Manual in covering environmental factors. Chapter 2 on atmosphere and chapter 3 on temperature give relevant background information applicable to cold environments. Many research charts, graphs, etc. Applicable to professional audience. Each chapter well referenced.

Paton BC: Disturbances due to cold. In: Current Therapy, Conn HF (ed). Philadelphia, W B Saunders Co, 1975, pp 821-825.

Discusses chilblains, frostbite, immersion foot, and hypothermia. Emphasis on prevention and treatment. Applicable to medical/paramedical audiences.

Post PW et al: Cold injury and the evolution of "white skin." Hum Biol 47(1):65-80, 1975.

Anthropologically oriented research literature study based on the thesis that dark pigmented persons are more susceptible to cold injury than light skinned persons. Applicable to professional audience. Thirty-five article bibliography.

Rockwood CA (ed) et al: American Academy of Orthopedic Surgeons - Emergency Care and Transportation of the Sick and Injured, 2nd ed. Menasha, Wi, George Banta Co Inc, 1977.

General manual covering EMT emergency case problems and procedures. Chapter 41 is cold-exposure specific (pp 309-316). Applicable to paramedical audience.

Stoffel RC: Emergency Preparedness Today. State of Washington, Department of Emergency Services, 1976.

One hundred and thirty-one page manual covering essentials of survival in natural and man-made emergency/disaster conditions. Cold-specific areas are taken from Hedblom's Polar Manual, 1965 ed. (out of print). Applicable to all-hands. One hundred and sixty article bibliography - survival specific.

US Army: FM 31-70, Basic Cold Weather Manual. Washington DC, US Government Printing Office, 1968.

General overview of personnel, environmental, and operational factors required for cold weather operation adaptation. Includes glossary of specific cold terminology. Applicable to universal audience. Elaborate, general Army field and training publications bibliography.

US Army: TM 10-275, Cold Weather Clothing and Sleeping Equipment. Washington DC, US Government Printing Office, 1968.

General manual presenting information and guidance on clothing and sleeping equipment issued for personal use. Applicable to general audience. Bibliography of associated, military manuals and films.

US Army: FM 21-11, First Aid for Soldiers. Washington DC, US Government Printing Office, 1976.

Chapter 9 is a good, all hands reference book covering basics in CO poisoning, immersion foot, frostbite, and snowblindness. Very brief.

US Army: FM 21-10, Field Hygiene and Sanitation. Washington DC, US Government Printing Office, 1970, pp 84-87.

Very brief article discussing diet, clothing, and cold weather injuries, including snowblindness and carbon monoxide poisoning. Applicable to general interest/all level audience. Limited military manual bibliography.

US Army: FM 31-72, Mountain Operations. Washington DC, US Government Printing Office, 1971.

General operations manual directed at equipment and supply maintenance and utilization. Applicable to general interest audience. Elaborate, general Army field and training publications bibliography.

US Army: FM 31-71, Northern Operations. Washington DC, US Government Printing Office, 1971.

General operations manual directed at equipment and supply maintenance and utilization. Inlcudes glossary. Applicable to general interest audience. Elaborate, general Army field and training publications bibliography - also includes limited Army training film list.

GENERAL COLD con.

US Army: TC 21-3, Soldier's Handbook for Individual Operations and Survival in Cold Weather Areas. Washington DC, US Government Printing Office, 1974.

Excellent all-hands, pocket manual stressing maintenance, preventive, and survival factors.

US Army: Wind chill in the Northern Hemisphere TR-EP-82 Project reference 7-83-01-005A Natick, Mass. USAQR&EC, Feb. 1958.

Nine page USARIEM study which discusses the wind chill index and presents aids for computing wind chill applicable to general audience. Eleven article bibliography.

US Government Printing Office: CO and You - Carbon Monoxide Poisoning. Washington DC, 1958.

Brief pamphlet providing signs, symptoms, prevention and first aid treatment of carbon monoxide poisoning. Applicable to universal audience.

US Navy: Cold Injury, NAVMED P-5052-29. Washington DC, US Government Printing Office, 1976.

Detailed bulletin on prevention, management, and treatment of cold injury. Overview of etiological factors. Applicable to medical/paramedical audiences. Five article bibliography.

US Naval Flight Surgeon's Manual. Washington DC, US Government Printing Office, 1968.

Twenty-one chapter text developed specifically for flight medical officers. Chapter 12 is devoted to environmental factors in survival, work, injury, and disease. Briefly discusses hypothermia and sea survival. Sections of the book cover acclimatization (general), external factors affecting the environment, CO and CO_2. Applicable to professional audience. Each chapter is well referenced. (New edition to be available in 1978.)

US Navy: Manual of Naval Preventive Medicine, NAVMED P-5010-3. Washington DC, US Government Printing Office, 1974, ch 3.

Brief, well organized article discussing cold exposure factors, freezing and nonfreezing injuries, and treatment. Applicable to medical/paramedical audiences.

US Navy: Naval Arctic Manual, ATP-17(A) (NATO Handbook). Washington DC, COMTAC, 1970.

Detailed manual - provides basic information on environmental and operational problems. Applicable for shipboard CO's and shore Operational Planning Officers. Chapters 9 (Personnel) and 17 (Survival) are applicable to universal audience. Some chapter-specific bibliographies.

Weber C: Some biological factors involved in Arctic warfare. Mil Med 124:497-504, 1959.

Brief discussion on human biological factors, including racial, physiological, diet, vitamins, and acclimatization. Applicable to general interest audience.

Wyndham CH: Adaptation to cold. In: Environmental Sciences: Physiology, Environment, and Man; Minard LOH (ed). New York, Academic Press, 1970, pp 202-204.

Two-page essay presenting a short climatization study stressing cultural adaptation to cold of the Kalahari bushman. Applicable to general interest audience. Twenty-seven article bibliography which includes heat acclimatization also.

INFORMATION SOURCE LIST

The following information is provided to assist in the identification of resource and instructional materials for military cold weather operations.

CORRESPONDENCE COURSES

NAVEDTRA 10997-C, "Low Temperature Sanitation and Cold Weather Medicine."
A three-assignment course discussing the effects of cold on water supplies, sewerage disposal, and health maintenance. Limited coverage of specific cold injury treatment.

Submit request for enrollment on form NAVEDTRA 1550/1 to:
Commanding Officer
(Correspondence Courses Training Branch)
Naval School of Health Sciences
National Naval Medical Center
Bethesda, Maryland 20014

NAVEDTRA 10946-B, "Naval Arctic Operations."
An eight-assignment correspondence course designed for operational officers, discussing arctic geography, weather, and ice conditions. Small area devoted to personnel and survival requirements.

Course administered by:
Naval Education and Training
Program Development Center
Building 903, Ellyson
Pensacola, Florida 32559

#03:40, "Cold Weather Operations."
A five-assignment course discussing briefly all aspects of cold weather operations. Applicable for all hands audience.

Submit request for enrollment on form GPO 912-130, MCI Enrollment Application, Stock #433-2784, to:
The Director
Marine Corps Institute, Marine Barracks
Box 1775
Washington, D. C. 20013

PROGRAMMED INSTRUCTION

PI 73-430-705-1, "Environmental Factors in Cold Injury"

A twenty-seven page programmed instruction that presents a concise overview of specific cold injuries and the host and environmental factors that influence their occurrence.

PROGRAMMED INSTRUCTION con.

Published by:
US Army Medical Field Service School
US Army Health Services Command
Publications, Building 2290
Fort Sam Houston, Texas 78234

MILITARY PUBLICATIONS

US Navy Publications (NAVMED) and Tri-service Publications (TB Med, NAVMED, AFP)

Order NAVMED from:
Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, Pennsylvania 19120

US Army Publications (FM, TC, AR, TB, TM)

Order FM, TC, AR from:
Commander
USA AG Publications
2800 Eastern Boulevard
Baltimore, Maryland 21220

Order TB, TM from:
Commander
USA AG Publications
1655 Woodson Road
St. Louis, Missouri 63114

US Coast Guard Publications (CG)

Order CG from:
Director of Publications and Records
US Department of Transportation
US Coast Guard (G-MP-4/82)
Washington, DC 20590

FILMS

"Trench Foot" - MN 3726F
Discusses the clinical occurrence and treatment of trench foot among Army personnel in 1945.

"Immersion Foot" - H-A-PMB 625
Produced for the US Navy Global Medicine Series. Discusses signs, symptoms, preventive and treatment measures for wet water immersion foot.

"Arctic Survival" - A-2549
A Canadian film discussing cold injury prevention and survival measures when a helicopter is forced down in a severe, cold environment.

The above films are available for loan from:
Media Resources Branch
Naval Health Sciences Education and Training Command
National Naval Medical Center
Bethesda, Maryland 20014

"Prevention of Cold Injury" - TF 8-4879
An all-hands film describing the course, prevention, and symptoms of cold injuries.

"Freezing Injuries" - #144 n.d.
A medically oriented film narrated by Dr. W. J. Mills, Jr., discussing the clinical course of various cases of frostbite.

Information concerning area distribution sources of Army training films is obtained by writing:
The Armed Forces Institute of Pathology
Audio-Visual Support Center
Washington, DC 20306

"Cold Can Kill" - MB 12645
A British film discussing the incidence of hypothermia in cold environments.

For information regarding this film, contact:
Head Transportation Center, Operations Department
Marine Corps Development and Education Command
Quantico, Virginia 22134

"Cold Can Kill" - T-428
videotape of above film available from:
Audiovisual Resources Division (Code 26)
Naval Health Sciences Education and Training Command
National Naval Medical Center
Bethesda, Maryland 20014

WIND SPEED		COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS AN EQUIVALENT TEMPERATURE																				
KNOTS	MPH	ACTUAL THERMOMETER READING																				
CALM	CALM	F	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		C	4	2	-1	-4	-7	-9	-12	-15	-18	-21	-23	-26	-29	-32	-34	-37	-40	-43	-46	-48	-51
		EQUIVALENT TEMPERATURE																				
3-6	5	F	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
		C	2	-1	-4	-7	-9	-12	-15	-18	-21	-23	-26	-29	-32	-34	-37	-40	-43	-46	-48	-51	-57
7-10	10	F	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-80	-85	-90	-95
		C	-1	-7	-9	-12	-15	-18	-23	-26	-29	-32	-37	-40	-43	-46	-51	-54	-57	-62	-65	-68	-71
11-15	15	F	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
		C	-4	-9	-12	-18	-21	-23	-29	-32	-34	-40	-43	-46	-51	-54	-57	-62	-65	-68	-73	-76	-79
16-19	20	F	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
		C	-7	-12	-15	-18	-23	-26	-32	-34	-37	-43	-46	-51	-54	-60	-62	-65	-71	-73	-79	-81	-84
20-23	25	F	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
		C	-9	-12	-18	-21	-26	-29	-34	-37	-43	-46	-51	-54	-60	-62	-68	-71	-76	-79	-84	-87	-93
24-28	30	F	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
		C	-12	-15	-18	-23	-29	-32	-34	-40	-46	-48	-54	-57	-62	-65	-71	-73	-79	-81	-87	-90	-96
29-32	35	F	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
		C	-12	-15	-21	-23	-29	-34	-37	-40	-46	-51	-54	-60	-62	-68	-73	-76	-81	-84	-90	-93	-98
33-36	40	F	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
		C	-12	-18	-21	-26	-29	-34	-37	-43	-48	-51	-57	-60	-65	-71	-73	-79	-81	-87	-90	-96	-101
WINDS ABOVE 40 MPH HAVE LITTLE ADDITIONAL EFFECT		LITTLE DANGER (FOR PROPERLY CLOTHED PERSON) MAXIMUM DANGER IS FALSE SENSE OF SECURITY.						INCREASING DANGER DANGER FROM FREEZING OF EXPOSED FLESH. (FLESH MAY FREEZE WITHIN ONE MINUTE)						GREAT DANGER (FLESH MAY FREEZE WITHIN 30 SECS)								
		TRENCHFOOT AND IMMERSION FOOT MAY OCCUR AT ANY POINT ON THIS CHART																				

WIND CHILL CHART

SIMPLIFIED COLD PHYSIOLOGY

In order to understand the various physiological and psychological factors influencing cold weather adaptation, it is important to understand some of the normal functioning of the human body. Any deviation from this norm observed in ourselves or in those around us should be acted upon immedi ately.

When man is subjected to cold, reflex constriction of peripheral arterioles allow less blood to flow to the skin surface, thus minimizing heat loss. This effect is accen- tuated by a secondary vascular constriction caused by increased circulation of adrenalin with "stress." Apprehension causes increased suprarenal activity.

Body energy levels greatly influence adaptation. Rapid pace, running, shivering, and worry use enormous amounts of energy. Changing procedures, routes, methods, or equipment might prevent a major problem before it develops.

The body operates at an optimum temperature of about 99 degrees Fahrenheit. Regardless of temperature, the body core (innermost, central temperature) functions at peak efficiency only within a narrow 12-degree temperature range, whereas temperature in the extremities can drop to nearly that of the surrounding environment.

In cold environments, as body temperature begins to drop, blood supply to the extremities is automatically reduced to conserve heat in the central core where vital organs are located. Reduced blood supply to the extremities reduces sensory nerve activity, sending fewer electrical nerve impulses to the brain. This lack of sensory input or stimulus prompts the brain to "shut down" much like a computer with no input. The brain tends to "go to sleep" or to operate at reduced efficiency. The resulting irrational behavior, coupled with reduced coordination, often precipitates stress, dehydration, chemical imbalances, and other physiological problems that drastically lower body operating efficiency. It is essential to safeguard individual problem solving ability and judgment with thorough understanding of body indicators.

Abstracted from the following: Hedblom EE: Polar Manual, 4th ed, 1965. Stoffel RC: Emergency Preparedness Today, 1976.

Energy in the Human Body

Any activity requires using some body energy. Even while asleep, the body consumes energy in maintaining life and internal body functions. During work, much more energy is used.

The human body manufactures energy from air, water, and food through metabolism. Metabolism converts fuel into three kinds of energy: electrical for nervous system functions, mechanical for muscle activity, and chemical for various functions within body cells. Any shortage of air, water, or food results in a shortage of energy and possible serious consequences. Body energy is measured in terms of heat produced during various activities. The basic metabolic rate, measured under standard conditions, is about 1400-1800 calories per day just to maintain the body at its least active waking level (obviously, this varies with individuals).

Body Heat Regulation

Newton's law of cooling states that the rate of cooling of a body warmer than its surroundings is proportional to its surface area, and to the difference in temperature between the hot body and the cooler surroundings.

Physical cooling is regulated by circulatory changes, and by sweating, as in cases where people become overheated. This heat is lost normally in the following proportions:

1. Direct loss from the body surface, 63-7-%
2. Insensible skin perspiration, 14-18%
3. Saturation of inspired air with water vapor, 8-9%
4. Warming of inspired air, 2-9% (at -40^{o})
5. Warming of foods and fluids ingested to the temperature of the excreta, 1% or less

Chemical heat regulation involves the production of greater or lesser amounts of heat principally through the oxidation of carbohydrates in the body musculature. When a man is at 82^{o} F. in air or at 91^{o} F. in a water bath, there is a call for extra heat production. The colder the man, the more production. The more physically fit the man, the more efficient the heat production.

Muscle heat is produced by normal <u>contractions</u> of exercise, in the cold by increased muscular tension or <u>tonus</u>, and when the body core or inner temperature falls from about 99^{o} F. to

as low as 64.4° F. by shivering. Increased tonus and shivering are involuntary.

If while working outdoors one gets so cold that involuntary shivering ensues, heat production can be increased by as much as 20%, by tensing opposing muscles without making motion or doing work. This is a temporary expedient which may bring on fatigue rather quickly.

It is believable that significant heat is produced by the body's chief chemical plant, the liver. This seems borne out by the remarkable number of men in polar regions who have developed liver enlargement without evidence of disease or gross alcoholism.

Shivering is depressed by hypoxia (carbon monoxide from smoking as well as from motors, and altitude cause this), by antipyretics such as aspirin, by the magnesium ion, by insulin, and by anesthesia or narcotics (including alcohol).

The entire heat regulating mechanism, chemical and physical, is depressed by anesthetics, narcotics, sleep, fatigue, and shock.

Chemical production of heat is under the control of the thyroid gland which controls the Basal Metabolic Rate or the rate of oxidation of the body. Physical control is to some degree under the suprarenal gland. Both thyroid and suprarenal are under the control of the pituitary.

The body produces the least heat while asleep. Heat output increases with activity. Humans are "warm-blooded" animals with effective thermostatic controls which keep body temperature regulated at about 99 degrees Fahrenheit (37 degrees Centigrade) regardless of environmental temperature. This condition is necessary for vital chemical reactions to occur within the body. As temperature increases, chemical reactions occur more rapidly (7 percent for each 1 degree Fahrenheit rise), and conversely, body functions slow down as body core temperature decreases. Proper body functions depend on thermal balance which maintains normal body temperature. In a warm climate, heat loss from the body is reduced, while cold temperatures accelerate body heat (and energy) loss.

Beyond certain limits, body heat regulation mechanism breaks down. Very few people recover after body temperatures of 106 degrees Fahrenheit or over because fever increases metabolic rate, and excessive temperature causes delirium and death. If

body temperature decreases faster than regulatory mechanisms can keep up, brain activity controlling heat regulation fails and temperature falls further. At about 80 degrees Fahrenheit, our built-in heart pacemaker fails, and death comes due to cardiac fibrillation.

The body loses heat through conduction, convection, radiation from the skin, and evaporation of perspiration and moisture from lungs. Loss of heat is effected by air temperature and colder objects in contact with the body. If outside in the cold, even at rest, more energy is used to maintain body temperature than would be used sitting in a heated home or office. Energy needs also increase when wind chill factors lower the effective temperature, or if clothing becomes wet, reducing its insulating properties.

All foods produce energy, their body heat producing potential depends upon the kind and quantity of food intake. While protein is the greatest resource for tissue building and reparation, it is not directly usable for muscular action. Carbohydrates and fats produce energy directly usable for energy.

Fats are not only high energy foods, and they also furnish the necessary components for the production of fat soluble vitamins A, D, E, and K. They are both animal and vegetable in origin. The end products of oxidized fats are energy, CO_2 and H_2O.

Fats and carbohydrates are called "protein sparers" since their presence prevents the body from having to burn its own protein (blood and muscle) to give energy. The body selects carbohydrates first to burn, then fat, then protein because of ease in metabolism. Fat and carbohydrate mixtures of 60-40 appear to be best for cold weather diets for a number of complicated reasons. Fairly large quantities of fat are essential to a purely protein diet as proven by men who have died of "rabbit starvation" in the north after trying to live on relatively fat-free rabbit meat alone. Symptoms are enormous appetite, distention, and diarrhea. Untreated, death occurs within 3 to 8 weeks.
NOTE: Current research indicates a definite relationship between dietary fat intake and the incidence of cold-related dehydration.

Body Water Needs

Water is essential for proper body function. Approximately two-thirds of the body weight is water. Two-thirds of this water is inside body cells, and the other one-third is in veins, body cavities, and other spaces. Lack of water has a much faster and more serious effect on the body than lack of food. A man engaged in light activity loses about 2 to 2½ quarts of water every day.

Generally, water intake is regulated by thirst - a complex response with at least two different mechanisms. When body water content falls below a certain level, saliva decreases, the throat gets dry, and an urge to drink water is created. In addition, when body water content falls, there is a greater concentration of salt and other dissolved elements in remaining cellular and body fluids. This increase is recognized by the brain and converted into the sensation of thirst, which originates in the same part of the brain as appetite control.

Fluid loss through urination is relatively constant under normal conditions. The kidneys filter out body wastes and help eliminate excess fluid. Kidney function requires a certain amount of liquid from the body's supply. Under severe conditions of the body water loss, there is insufficient water to support normal kidney function. Eventually, the kidney functions usually returns to normal when body fluids are restored.

Water loss through sweating and through the lungs depends on temperature, humidity, air movement, and work. Usually, inhaled air has relatively little moisture, and exhaled air is saturated with it. (This is why you "see your breath" on cold days). Anything that increases breathing rate increases the rate of water loss. Anytime more water is lost than is taken in, one faces dehydration. This fluid must be replaced for normal body functions to continue. All body functions require a water/salt balance almost like sea water.

Seventy percent of body weight is water - almost two-thirds of it is contained in cells. A small fraction makes up the liquid part of the blood, and most of the remainder forms a bath surrounding cells. Body cell function is preserved at the expense of other functions. As water is lost through evaporation or perspiration, salt concentration in the circulatory system increases. To maintain balance, water is shunted from cells, causing even further water loss as more moisture is lost through perspiration. In early stages of dehydration,

thirst tells us the water tank needs filling, but altered salt/water balance can affect the brain's normal functions. Nausea and abdominal cramps show up in further stages of dehydration, reducing psychological need for water, and compounding problems of water loss. While dehydration is normally thought of as a hot climate problem, the difficulty of melting snow or ice to replace body fluids makes it significant in snowy, cold conditions. At higher altitudes, relatively low humidity, combined with need to breathe faster, adds to the danger of dehydration.

Dehydration impairs mental functioning, and becomes a common factor in accidents involving fatigue and judgment errors. Since thirst is the best water regulator in normal body functions, drink all the water needed when thirsty, and have plenty of water with meals.

Muscle Energy

The body takes in food and water to provide energy to sustain life and normal physical functions. The body also has exhaust systems to eliminate food wastes. The goal of the energy system is "go power" for the body which depends on normal functioning of intake and exhaust systems. All exhaust system losses must be covered by intake of fuel, water, and air. Working muscles use oxygen supplied by the breakdown of muscle glycogen into lactic acid. As muscles work, the glycogen content of the muscles decreases, while the lactic acid concentrations of the blood increases. As muscle activity ceases, oxidative metabolism is used to reconvert most of the lactic acid into muscle glycogen. The oxygen used to provide this excess metabolism is referred to as the "oxygen debt." With less oxygen, replacement of muscle energy glycogen is slowed and muscles can work only for shorter periods.

A steady pace is better than rushing and resting. There is only so much stored energy in the body. It can be squandered by hasty, rash activity, or husbanded and productively used for survival.

Exercise increases metabolic rate, doubling or tripling for short periods of effort, with possibility of 10 to 15 times the increase. Total body energy supply is limited. Like an automobile, the body can only go so far before it needs refueling. With normal activity, a car goes "x" miles per gallon. "Hot rod" driving reduces mileage, and the car needs fuel more often. The human body operates in much

the same way. Rational control of activity determines how long the body's energy fuel supplies last.

Physical conditioning improves the body's ability to meet physical exertion by improving muscle efficiency and increasing muscle mass. Larger muscles distribute strain to more individual muscle fibers, so each fiber carries a smaller load. In addition, conditioning improves circulation, and permits the heart to respond to an emergency without being overstressed. An overstressed heart could quite possibly fail.

Mental Attitude

Mental attitude is also extremely important in energy conservation. A positive mental attitude requires less energy expenditure than an unsure attitude. The pro uses less energy than the rookie. Inexperienced people waste energy on anxious stress, and have no reserve to meet the unexpected. A positive mental attitude gives that small reserve of energy needed in cold environment stress situations.

Physiological Distress Indicators

Body indicators are vital during great physical stress. They tell what is happening within the body. A knowledgeable person recognizes danger signs and acts accordingly. Heat and cold initially present subtle, unpredictable effects - which often "sneak up" on the unwary. Automatic temperature controls are designed to keep the body alive, using simple safeguards. When disregarded, the body's thermal regulating system slows or even stops some body functions until balance is restored.

Sensory nerves near the skin surface monitor reaction to heat and cold. When skin temperature increases, nerves automatically dilate pores, and flush a saline solution (perspiration) onto the surface. Perspiration evaporates, cooling the skin. As skin temperature drops, blood vessels and capillaries constrict to decrease blood flow to the body's periphery to maintain core temperature. Pores also constrict, and "goose bumps" are formed. After prolonged chilling, the skin becomes numb, then painful. Reduced blood supply impairs muscle coordination and functional ability. Hands and feet are usually first to go. Any part that is numb from cold does not have enough blood supply for proper cell function. Insulate the area or supply external heat to prevent serious problems.

Extended exposure to mild chill or what actually feels cold indicates a gradual decrease in the body's energy reserves. If usual heat-producing mechanisms do not work and temperature begins to drop, metabolic rate increases to about 3 times normal. This shows up as intense shivering and violent shaking with massive demands on body energy reserves. This further hastens the slide into semiconsciousness and also accounts for deep fatigue felt after a cold dunking or a long exposure to a chill. Although humans throughout the world inhabit environments where temperatures range from -80 degrees Fahrenheit to +140 degrees Fahrenheit, the body can only operate efficiently within a 12-degree body core temperature range. Survival is dependent on one's ability to read body thermal signals.

Dehydration

As previously stated, dehydration is a physiological condition that results from a deficit of total body water. In cold regions, the body water replacement stimulation of the thirst mechanism is not as effective as in temperate or tropical climates. When man is subjected to cold, reflex constriction of peripheral arterioles allows less blood to flow to the skin surface. With peripheral arterial constriction, cardiac output is increased, blood pressure and pulse rate rise, and urinary output is increased (cold diuresis). Excessive drinking of hot coffee, tea, and chocolate also stimulate kidney function. Add increased water loss due to inspiratory hydration of extremely dry polar air, and alarming dehydration sometimes occurs. Deep orange or brown concentrated urine causes dysuria (burning), urgency, and frequency of urination. Concentration certainly predisposes to kidney and bladder stones. Dehydration contributes to constipation, hemorrhoids, and headaches.

Dehydration is almost as much of a problem in cold as in the desert because water is frozen into snow or ice. Some streams or lakes may give access to water. (Caution: immersion in winter environments is extremely hazardous). Even though temperatures are below freezing, if the sun is shining, it is possible to melt snow on dark plastic or tarp, a flat rock, or surface that absorbs sun heat and is arranged so water drains into a hollow or container. It is better to melt ice for water rather than snow (more water for volume with less heat, faster, using less fuel). Melt snow a little at a time in a pot, pressing snow down to prevent burning the pot.

A day or two of eating ice or snow results in swollen, raw mucous membranes in the mouth which may be painful enough to prevent eating or drinking until inflammation eases. Never eat snow as a primary water source. The expenditure of energy to melt it is too costly. Man needs about two quarts of water every day to maintain normal excretion, both urinary and bowel. Because thirst is not always increased too much, because it may be inconvenient to stop to melt snow or ice for water, or because water should always be purified chemically or by boiling, there is a tendency not to drink enough water. Never underestimate the importance of drinking water.

Oxygen Deficiency

Very little thought is given to the air humans breathe. The necessities of life established air as the most important physical priority because time in its absence in estimated at about three minutes. However, lack of oxygen in air may be hard to recognize. Altitude differences or gases and other foreign materials in air may cause oxygen starvation.

Hypoxia occurs when the percentage of oxygen goes down from roughly 20% of the room air, and carbon dioxide climbs from a little less than 1%. Man will breathe deeper to better aerate. (If carbon monoxide is also present, he will die more rapidly). When the partial pressure of oxygen sinks from 157 mm of mercury (sea level) to 30 mm, the average active, healthy man becomes unconscious, and shortly thereafter dies. Lowering of the partial pressure of O_2 is naturally more hazardous at high altitudes where the partial pressure of oxygen is normally less than at sea level. Carbon monoxide is a heavy, odorless, colorless, tasteless, asphyxiant gas resulting from the incomplete combustion of fuels, e.g., coal, wood, and other hydrocarbon fuels. Use of petroleum products in internal combustion engines and stoves makes poisoning common in modern cold region activities. Carbon monoxide kills through asphyxia even in the presence of adequate oxygen, because oxygen-transporting red blood cell hemoglobin has a 210-times greater affinity for carbon monoxide than for oxygen. Rate of absorption is increased with carbon monoxide concentration, with rate and depth of breathing, increased activity or altitude, time of exposure, blood concentration (polar dehydration), temperature, humidity, and decrease in percentage of oxygen inspired.

Hyperventilation

Quite commonly, people experience difficulty when they breathe too hard and too fast. This type of breathing often results from emotion expressed in deep sighs or quick short breaths. Symptoms could include sharp chest pains, rapid muscles spasms, numb hands and feet, and tingling in the extremities with faintness and dizziness. These symptoms are usually alarming because of their similarity to heart attack.

The problem is not caused by taking too much oxygen, but by releasing too much carbon dioxide which upsets the delicate acid balance needed for cellular chemical reactions. The usual cure is breathing into a small bag to reinhale carbon dioxide.

During hyperventilation following strenuous exercise at temperatures below -25° Fahrenheit, particularly at high altitude, man coughs up blood from the tracheobronchial tree. This is not a "frostbite," as there is no freezing of tissues. Marked respiratory mucosal hyperemia (as in flash burns) causes this expectoration of frank blood. Concurrent or as an aftermath, asthmatic-type breathing may occur for periods of hours to a day or two, depending on the severity of exposure, altitude, and the man. It can be prevented to some extent on trail by slowing down and by using parka hoods, face masks, folded mufflers, etc., which enhance rebreathing of some warmed, humidified, expired air. There is no immunity for the condition. Treatment is symptomatic. Humidify quarters to 30%, bed rest, steam inhalations, and NO SMOKING until breathing difficulty, hemoptysis, and cough subsides.

Mountain sickness is caused by walking or climbing in a reduced-oxygen atmosphere. At least two days are needed to adapt to these conditions - most people take longer.

With altitude acclimation, breathing speeds up and the body manufactures more red blood cells to pick up more oxygen. Mountain sickness symptoms affect different people differently. Some common symptoms are: headache, disturbed breathing, insomnia, shortness of breath, irritability, abnormal muscle fatigue, vomiting, and deterioration of judgmental ability.

Special Considerations for Those with Medical Problems

One of the greatest virtues of our modern era is advanced medical technology, with medications for most aches, pains, and miseries. Unfortunately, some medications drastically increase effects of dehydration, hypoxia, chemical imbalance, and possibly even temperature fluctuation. One must be aware of possible side effects and restrictions caused by medications taken.

People with heart or circulatory problems must be particularly aware of the effects of cold. Cold may impair adequate circulation, precipitating frostbite or more rapid hypothermic onset. Extreme heat and cold impose heavy demands - difficult even for people who are physically fit. Persons under medication with heart problems must be especially cautious in cold weather.

C O L D

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Man has survived on this planet for the past 4,000,000 years. During that time he has been exposed to, has tolerated, and has adapted to a wide spectrum of thermal stress--both heat and cold.

The maximal limits that a living cell can tolerate extend from about -1° C or 31° F to 45° C or 113° F. At the lower reading ice crystals which have formed during the freezing process physically break the cell apart. At the upper reading vital proteins inside the cell coagulate from thermal heat.

A protected man may be able to tolerate variation in the temperature of his external environment from -50° C or -122° F up to 100° C or 212° F. He can, however, only tolerate a variation of about 4° C in his own internal deep body temperature without impairment of his optional physical and mental work capacity or survival capability.

Man is able to survive and adapt to the temperature variations in his external environment by various physiological adaptations so that he is able to live his entire life maintaining a core body temperature which is only a few degrees removed from his thermal death point.

TEMPERATURE REGULATION

The control of body temperature, the balance between overcooling and overheating, is the role of temperature regulation. This regulation endeavors to keep the temperature of certain body tissues such as the brain, heart, and gastrointestinal tract at a relatively constant temperature. Within the body the temperature of various areas is by no means uniform.

The greatest gradient in temperature is found between the outer shell of the body--basically the skin--and the core or central areas including heart, lungs, abdominal organs, and brain. The temperature of the core may be as much as 20° C or 68° F higher than that of the shell. The ideal difference between shell and core is about 4° C at rest.

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In the hypothalamus and adjacent preoptic region of the brain, there are clusters of nerve cells which, when cooled or heated in experimental animals, will elicit the same physiological reactions manifested by the animals that have been exposed to external environmental heat and cold. This temperature regulatory nerve center is connected via nerve pathways to specialized receptors in the skin.

These receptors consist of a network of fine nerve endings which are specifically activated by heat or cold stimuli. The temperature receptors are especially sensitive to rapid changes in environmental temperatures and are highly susceptible to adaptation.

This temperature-regulating center is mainly located in the hypothalamus. It behaves like a thermostat. Its set point may change during different physiological conditions. The thermo-sensitive receptors, particularly in the skin, contribute to the regulation of the set point.

Man and other homoiotherms regulate their internal body temperature within narrow limits by physiological control of blood flow from sites of heat production in the deep tissue to the body surface. This heat is a by-product of the metabolic processes.

The energy required to sustain all body functions, both at rest and during physical activity, is derived from the enzymatically controlled oxidative combustion of fuel substrates such as carbohydrates, fats, and proteins with carbon dioxide, water, and nitrogenous wastes as end products. These oxidative reactions are exothermic and occur predominately to the metabolic furnace of the liver and large mass of muscle tissues. Fortunately, these tissues are highly vascular structures.

At rest, the average man of 70 kilograms of body weight with two square meters of skin surface produces 1.4 kilocalories of heat per minute or 90 kilocalories per hour. During periods of very strenuous physical effort, this same average man can produce up to 700 kilocalories per hour.

The human body has about 20 to 25% efficiency in converting the enzymatically released energy into productive work. The rest is dissipated as heat.

If the heat content of the body is to remain constant, the heat production and heat gain must equal heat loss. In other words, the metabolic heat production plus or minus the radiant heat exchange, plus or minus the connective heat exchange, minus the evaporative heat loss, equals the storage of heat in the body.

Conductive heat loss is usually negligible under most environmental conditions; however, it increases in importance if the body is immersed in cold water such as the ocean, because water has a heat-removing capacity which is some 20 times that of air. The body loses heat to the environment by evaporation in a hot environment and by radiation and convection in a cold environment.

EFFECTS OF COLD

Most of the militarily strategic areas of the world where exposure to cold stress can be anticipated are rather desolate and dismal locations. Therefore, it is important to realize that, except in carefully controlled laboratory experiments, it is virtually impossible to isolate cold stress from other stress factors which are likely to affect men or animals exposed to frigid locations.

In most snow-covered areas there can be a profound sense of isolation and an acute awareness of dependence on others. The effect of a cold, miserable wind with velocities up to 125 knots persisting for periods of time anywhere from several hours to several days can be emotionally devastating.

Frequently, these cold areas are at significant elevations above sea level so that there can be a reduction in atmospheric oxygen with its added burden on the cardiorespiratory system and bone marrow. Many of these locations are close enough to the north or south pole so that there is the additional stress of 4 months of continuous daylight with the sun well above the horizon 24 hours every day and, conversely, 4 months of darkness. Sunglare on snow and ice is an additional stress factor.

The need to wear many layers of special clothing, frequently weighing from 10 to 22 pounds, creates another problem. This makes the wearer very clumsy in performing many routine procedures. Mittens are more protective than gloves but are more cumbersome.

Trying to aim and fire a rifle in the cold is difficult enough with gusting wind buffeting the weapon and yourself. Due to the shivering, any attempt to reload a rifle can be a frustrating experience. To clean or repair a rifle under these conditions is almost impossible.

Verbal communication is usually much more difficult in a cold environment and is an additional stress condition.

Fortunately, man is a homoiotherm; if we can enable him to maintain his body heat, he can survive and perform successfully in frigid climes, both natural and manmade.

The adverse effects of low environmental temperatures on the human body may be localized or generalized, or a combination of both. They may occur at temperatures above or below freezing and under wet or dry conditions. The pathophysiologic features of cold injury are dependent on the environmental temperature, exposure time, and the individual susceptibility or resistance.

GENERAL PHYSIOLOGIC EFFECTS OF ACUTE COLD EXPOSURE

The physiologic response to total body cooling is manifested by the conservation of thermal energy and by an increase in body heat production. With prolonged or severe exposure the body's defense mechanisms fail, heat loss exceeds heat production, and the body temperature falls.

During the initial response to cold exposure, stimulation of the sympathetic nervous system causes a reflex superficial vasoconstriction with shunting of blood to the internal organs. This is accompanied by reflex shivering which increases muscular activity, heat production, and oxygen consumption.

Constriction of cutaneous capillary beds is manifested by pallor, mottling or cyanosis of the skin.

In hypersensitive individuals, release of histamine-like substances may cause urticaria.

In responding to stress, the adrenals secrete epinephrine which accelerates the cardiac rate, increases blood pressure, and mobilizes liver glycogen stores.

Blood coagulability is increased and pooling of water in the extravascular spaces such as in the skin, muscles, and subcutaneous tissues, results in hemoconcentration.

Sudden exposure to extreme cold causes reflex muscle spasm and respiratory arrest.

A more gradual cooling process will eventually cause unconsciousness with rectal temperatures between 86 and 89° F. This is also accompanied by slowing of the respiratory and heart rates and falling of the blood pressure.

Although some individuals have survived rectal temperatures as low as 72° F, ventricular arrhythmias such as ventricular fibrillation and cardiac arrest may be expected whenever the rectal temperature falls below 80° F.

In persons exposed to rain, snow, wind, and cold, the onset of hypothermia may be insidious. The first warning may come with violent shivering, marked fatigue, stubbornness, and hallucinations as the body temperature drops below 91° to 95° F.

I have seen Marines undergoing cold weather training who were shivering and shaking so uncontrollably that they could not keep a thermometer in their mouths. I have lost thermometers because their teeth were chattering uncontrollably and their thermometers would fall to the floor.

Unconsciousness and cardiorespiratory arrest may rapidly follow hypothermia unless resuscitative efforts are begun immediately.

There is a less serious problem in what is called "cold shock." This may be produced when personnel pass from heated areas into air-conditioned cooled spaces. Individuals experience a rapid loss of body heat due to an increased evaporation of sweat from wet skin and damp clothing. Chilly sensations and shivering are common manifestations.

A corollary is seen in persons who move into outdoor heat from excessively cooled environments. Personnel in this situation experience sudden dilation of superficial blood vessels and flushing.

"Cold shock" and its thermal counterpart may be minimized by regulating the air-conditioned spaces so that the differential temperature between those areas and heated or outdoor environments does not exceed 15° F (dry bulb).

Medical personnel should be alert to the occurrence of these phenomena in individuals who work in the daytime

heat of natural outdoor environments or the high temperatures of engine rooms, firerooms, galleys, and laundries. Persons entering cold meat and food lockers may be protected from "cold shock" by the temporary use of suitable clothing or by limiting the frequency and duration of their exposure.

Some researchers feel that recurrent exposure to cold and to changes in environmental temperatures may somehow lower resistance to infectious diseases; others feel that people are healthier living in a constant cold environment.

Research in this area is incomplete, and definitive conclusions cannot be stated at this time.

HYPOTHERMIA

Hypothermia is the medical term for the rapid, progressive mental and physical collapse that accompanies the chilling of the inner core of the human body. It can strike anyone exposed to wet and cold. You don't have to be exposed to severe cold for a long time to die. Most deaths occur in air temperatures between 30 and 50° F, usually when combined with rain, fog, or mist.

Water at 50° F or lower is too cold for human beings to endure. It is particularly dangerous when it runs down the neck and legs or when held against the body by wet clothes. Cold water drains heat from the body. Wetness destroys about 90% of the insulating quality of cloth.

The first defense against hypothermia is to keep dry. Also important are to keep out of wind and keep exposure to cold damp weather as brief as possible.

The moment the body begins to lose heat too quickly, it makes involuntary automatic adjustments to preserve normal temperatures in the vital organs. The spontaneous response most people have is to exercise, at least move around, so as to keep warm. Both of these voluntary and involuntary reactions tend to drain the body of its reserves.

GENERAL EFFECTS OF EXCESS COLD EXPOSURE

General hypothermia is cooling of the body to the point of caloric reserve depletion and depression of the normal core temperature. It is a serious and often fatal state because homoiothermic control is unstable at rectal temperatures below 34.5° C or 94° F. Body temperature control may be lost if cooling persists. As the core temperature drops below 94° F, the patient can become uncoordinated, semicomatose, and dysarthric. The patient may progress into coma and cardiorespiratory failure even before the rectal temperature drops to 31° C or 88° F.

Since standard rectal thermometers do not record below 94° F, it is better to use a rectal probe that is capable of recording temperatures as low as 70° F, if it is available for you to use.

Generalized hypothermia may be classified as induced or accidental.

Induced hypothermia is a valued adjunct to general anesthesia for select surgical procedures. It is implemented under controlled operating room conditions by qualified anesthesiologists. Vital circulatory, respiratory, and cardiovascular functions are carefully controlled and monitored as the patient's body temperature is intentionally lowered and maintained at a predetermined level for the duration of the surgery. Under these circumstances, temperatures are generally maintained above 82° F.

Accidental hypothermia may be observed in newborns, in the elderly, and in association with certain lesions of endocrine and central nervous systems. In the military, it is most frequently seen in individuals who have been exposed to cold for prolonged periods of time. Fatigue, severe wounds, cold water immersions subsequent to aircraft-surface ship or submarine accidents, or combat damage, and inadequate cold weather gear, all contribute to the evolution of accidental hypothermia.

During World War II survivors of torpedoed ships or aircraft crashes at sea had a survival time of approximately 20 minutes in the cold waters of the North Atlantic, especially during the winter months.

Clinical case reports suggest that tolerance to deep hypothermia such as 77° F may occasionally be enhanced by the depressant effect of alcoholic intoxication and excessive doses of sedative drugs. This phenomenon, however, is unpredictable and should never be considered in the context of therapy.

Individual cold tolerance and the unreliability of the clinical signs of "death" during severe hypothermic episodes make it imperative that resuscitative measures be instituted immediately in all cases of accidental hypothermia. (The difficulty of knowing when a patient is actually dead or frozen lends some credibility to the famous Yukon Gold Rush ballad, "The Cremation of Sam McGee.") Cardiovascular and respiratory support should ideally be continued until more sophisticated means can confirm that all signs of life are absent.

CLINICAL MANIFESTATION OF HYPOTHERMIA

Never ignore shivering. Persistent or violent shivering is a clear warning that the victim is on the verge of hypothermia. If the victim denies he is in trouble, believe the symptoms--not the man. He may think he's got it licked by jumping up and down, clapping his hands, or running to stimulate his circulation. He's really only draining his energy reserve.

Symptoms of hypothermia include shivering, vague or slurred speech, memory lapses, immobile or fumbling hands, lurching or stumbling gait, drowsiness or the inability to get up after a rest or nap.

The patient is pale, comatose, and may appear dead. Respirations are slow and shallow and may be difficult to detect. The pulse is faint or absent. The precordial apical impulse may be inapparent. Blood pressure is frequently unobtainable. The victim is usually hyporeflexic and unresponsive to painful stimuli. The pupils are unreactive to light but are usually not dilated. The body tissues are semirigid and resist passive movement. Body temperatures are frequently below 82° F rectally and cannot be measured with the usual clinical thermometers. Urine output is negligible. Death may unfortunately occur in spite of apparently successful resuscitative measures.

Cardiorespiratory failure is an immediate threat to the hypothermia victim you have just successfully resuscitated. The commonest cause is ventricular fibrillation associated with the metabolic acidosis that results when tissues release the acid end products of anoxic metabolism. You can expect this crisis to occur within 2 to 3 hours after rapid rewarming of the hypothermic victim, or 12 to 24 hours if the patient has been gradually thawed at "room" temperature.

THERAPY OF ACCIDENTAL HYPOTHERMIA

Get the victim out of the cold and rain at once. Strip off all wet clothing. If impairment is mild, give him warm liquids to drink, dry clothing, and a warm bed or sleeping bag. If you have access to a fire, you can heat rocks or metal canteens filled with water and use them as bed warmers like a hot water bottle for the patient.

If the patient is stuporous but still conscious, try to keep him awake and give him warm beverages. If your sickbay happens to be a field tent, then strip the patient and put him into a sleeping bag--if necessary, with another person who is also stripped, because the radiant heat from skin-to-skin contact is the most effective treatment for advanced cases of hypothermia under field conditions in a cold environment.

For the severely hypothermic patient, initial resuscitative measures should concentrate on the restoration of vital functions. If respirations are present and ventilation is adequate, the therapist's attention may be diverted to other resuscitative measures. Otherwise mouth-to-mouth resuscitation and external cardiac massage (if indicated) should be initiated by the first person who finds the patient out in the field.

The patient should be kept warm during transportation to the appropriate medical facility and examined for concurrent injury and drug or alcohol intoxication. Supplemental oxygen will usually be indicated. An oral airway should be inserted in the unconscious patient.

Upon arrival at a medical facility, the apneic patient should have an endotracheal airway inserted to aid in the mechanical ventilation of the lungs and suction of the trachea. Intravenous lines should be established

for the administration of resuscitative fluids and the measurement of central venous or pulmonary wedge pressures. A nasogastric tube will allow evacuation of stomach contents and prevent aspiration. Stomach contents should be saved for analysis in forensic cases. An indwelling urinary catheter will serve to monitor urine output. Blood gas, pH, and electrolyte determinations will aid in effective management of the patient. Body temperature is best monitored by rectal thermistor probe.

On rare occasions blood gas determinations may indicate alkalosis rather than the anticipated severe acidosis. This usually results from the gastric suction, which may have been instituted, or from a Curling's ulcer and underscores the importance of obtaining frequent blood gas determinations if they are available.

Other organ systems are also affected by hypothermia, although our knowledge of which systems and to what extent is still limited. Some laboratory studies indicate that, soon after thawing or warming, the patient's uric acid level may rise above 12 milligrams percent. This elevated uric acid may not return to normal levels for some 48 to 72 hours or even longer in some patients. Presumably this is evidence of uric acid degradation which results from the ischemic effect of the hypothermic state on muscle tissue. However, since uric acid is derived from other organs as well, particularly the liver and bone marrow, the alteration in uric acid levels may well reflect more generalized changes.

Although it has not been confirmed, there is clinical evidence strongly suggesting that fat embolization may occur following rewarming of the frostbite victim.

REWARMING. Recovery from hypothermia is usually dramatically swift when you use the rapid rewarming method. However, even after the patient revives, he should be treated as a total emergency. He should still be properly monitored so that you can anticipate problems instead of playing catch-up medicine.

Rewarming must be approached with caution in order to avoid serious consequences. Controversy still exists as to the most effective and safest means by which to restore normal body temperature.

Rapid warming appears to be the most effective in those cases whose cold exposure has been brief, especially associated with cold water immersion. It is accomplished

by total body immersion in warm water at about 104° F. Hypothermic patients, however, may be inadvertently burned by this method and are subject to the poorly understood phenomenon of "rewarming shock."

Slow rewarming may be accomplished by the use of blankets, hot water bottles, heating pads, etc.; however, great care should be taken that the differential temperature between the patient and the rewarming medium is not too great.

Note: The age-old traditional method of vigorously massaging the patient is dangerous and is contraindicated. (Opposite of treatment for heat stroke.)

CARDIOPULMONARY CARE. Vital signs should be closely monitored under intensive care nursing procedures. After restoration of respirations, assisted ventilation and oxygen may be continued. Electrocardiographic monitoring is indicated. Ventricular arrhythmias, especially ventricular premature beats, tachycardia, and fibrillation are not infrequent in severe hypothermia. Intraventricular conduction delays are common and a "J-wave" may be seen in the S-T segment on the EKG. Digitalis may be indicated for rapid atrial fibrillation associated with a rapid ventricular response. Ventricular arrhythmias may be treated with lidocaine or procainamide; however, recent evidence suggests that quinidine and β-adrenergic blocking agents, such as propranolol, may have a more predictable pharmacologic effect.

METABOLIC AND FLUID BALANCE. Restoration of circulating fluid volume should be monitored by central venous or pulmonary wedge pressures. Blood gas and pH determinations are useful in following repair of the severe metabolic acidosis which usually accompanies profound hypothermia. Ringer's lactate is the restorative fluid of choice, and it may be supplemented with sodium bicarbonate solution as indicated. Overzealous measures can lead to serious fluid overloading of the cardiopulmonary circulation. Marked hypoglycemia is best managed by the administration of small amounts of 50% glucose. Physical exhaustion and prolonged stress can lead to adrenal insufficiency; therefore, the administration of 200 mg of hydrocortisone intravenously may be indicated in some cases.

Hypokalemia is common but is probably due to intravascular electrolyte shifts and does not usually require vigorous replacement.

When the patient has returned to a normothermic state, he should be kept in bed and his vital signs should be monitored until he is capable of ambulation.

LATE MEASURES AND COMPLICATIONS. Associated injuries can be dealt with when rewarming is completed. Intensive care measures are needed only until the cardiopulmonary, metabolic, and thermoregulatory functions have stabilized. Patients must be watched for acute renal failure and pulmonary infection.

SENSITIVITY TO COLD. Sensitization to further cold exposure frequently follows all forms of cold injury. This sensitivity may be brief with milder injuries or may last for years after severe episodes. Hypersensitivity to cold ("cold allergy") may be observed as a familial trait or as a sequela of cold injury. It is manifested by the appearance of generalized urticaria following cold exposure and may occasionally be complicated by asthmatic bronchospasm and shock.

LOCALIZED EFFECTS. In addition to the generalized effects of cold exposure, there can be localized effects. Few patients present with simple hypothermia. Many have general body cooling, hypothermia, along with nonfreezing local injuries such as chilblain, cold water immersion foot, as well as the local freezing injury called frostbite. Some patients can have frostbite without hypothermia. The cold can do its destructive work terribly quickly.

NONFREEZING INJURY. Nonfreezing local injuries can occur at ambient temperatures above 32° F but below 50° F, and are most frequently manifested as chilblain, called "pernio," and cold water immersion foot, called "trench foot." Exposure time is usually measured in hours. A high environmental moisture favors nonfreezing injuries by accelerating heat loss. Peripheral vasoconstriction, venostasis, and increased blood viscosity impair normal tissue oxygenation and the removal of cellular metabolites. This may be accompanied by increased capillary permeability and intravascular agglutination or sludging of red blood cells.

Chilblain is characterized by initial blanching and pallor, followed on rewarming by flushing, itching, and edema. Blistering may be present. Continued cold exposure may lead to hemorrhagic or ulcerative lesion.

Cold water immersion foot may be initially no more troublesome than chilblain; however, prolonged exposure leads to more severe anoxic impairment. During the hyperemic phase the pain is usually severe, tissue destruction is more pronounced, and gangrene may supervene with the resultant loss of the limb. Late complications of cold water immersion foot include dyshidrosis, Raynaud's phenomenon, and causalgia. Secondary complications, including infection and thrombophlebitis, are not uncommon.

FREEZING INJURY (FROSTBITE). The pathophysiology of frostbite is presently uncertain. It occurs only at environmental temperatures below freezing. The extent of tissue destruction depends primarily on the temperature and length of exposure. The freezing of intracellular and extracellular fluid results in the formation of ice crystals which mechanically disrupt cell membranes. True tissue freezing starts with the formation of a miniscule particle of ice in the extracellular space and continues with the accretion of more ice crystals as water is drawn out of the surrounding cells into the extracellular space.

It has been postulated that this process of ice crystal growth mechanically compresses the surrounding cells and possibly ruptures the cell membrane, either during the freezing or later during thawing. The most serious effect of extracellular ice formation may well be the cellular dehydration caused by the loss of intracellular water and the resulting destruction of intracellular structures.

There is a lack of agreement as to whether the injury is due to physical cellular injury and changes in vascular permeability or chemically due to vascular stasia and tissue hypoxia. We still have a way to go in understanding the multiple complex changes that occur with freezing and thawing, but it is safe to say that, as long as a part is frozen, it is literally in the freezer--that is, it is in a state of metabolic standstill.

Many of the gross anatomic and cellular changes associated with freezing injury seem to occur largely during the thawing process. If thawing is gradual,

some refreezing of the melt occurs, and the new ice crystals are actually larger than those formed during the original freezing. This causes further tissue disruption. Slow thawing also results in prolonged intra- and extracellular changes and may eventually result in intravascular corpuscular aggregation followed by thrombosis of the small vessels and occlusion of the distal vascular tree.

Some authorities prefer to describe cold injury in terms of degrees similar to burns:

A first degree frostbite is similar to mild chilblain with hyperemia, mild itching, and edema. No blistering or peeling of the skin occurs.

Second degree frostbite is characterized by blistering and desquamation.

In third degree frostbite there is necrosis of the skin and subcutaneous tissues with ulceration.

Fourth degree frostbite has the most severe tissue damage with destruction of connective tissues and bone accompanied by gangrene.

Secondary infections and the sequelae noted for nonfreezing injuries are not infrequent.

Some other authorities feel that it is more practical to classify freezing injuries as either "superficial" or "deep." Others believe that either of these designations is somewhat academic in the clinical situation because you usually don't know which one you are dealing with when you first see the freezing victim. Furthermore, the treatment for both is basically the same.

If a frostbite injury is not treated appropriately, a superficial freezing injury can be turned into a disaster for the patient. The old home remedy of ice and snow thawing and friction massage gives very poor results, particularly in deep injuries. On the other hand, excessive heat--temperatures above 115° F--gives absolutely disastrous results.

TREATMENT OF LOCAL COLD INJURIES. Usually a frozen extremity appears whitened, yellow-white, or mottled blue-white and is hard, cold, and insensitive to touch. Even a very shallow or superficial frostbite injury may have the appearance of being completely frozen solid because of the dermal freezing alone.

TREATMENT OF FROSTBITE is a four-stage procedure: prethaw, first aid, postthaw, and late-phased. The stage of treatment depends on whether the part is still completely frozen when you see it or whether someone along the line has tried to warm it.

If the frostbite victim is a considerable distance from a primary treatment center, the frostbitten extremity should be kept frozen until he arrives at the appropriate treatment facility. Thus, the frozen extremity should be padded or splinted--or whatever else has to be done--to protect the tissue during transit. Keep the frostbitten area away from the heater in the car or truck or ambulance or helicopter. Do not attempt any thawing when there is any danger of refreezing, since the danger of this is greater than the danger of remaining frozen. There seems to be a direct relationship between the period of time the tissue is in the frozen state and the amount of residual tissue damage. However, thawing, refreezing, and rethawing are most destructive of tissue.

First aid. Frozen body parts should be rewarmed until thawed. This can be accomplished by immersion in a water bath of 104 to 106° F. Temperatures above this level should be strictly avoided. In the field where water might not be available, it is possible that the frozen part may have to be warmed in the axilla of a normothermic companion. In most cases the frozen body part has already thawed by the time the victim comes to you for initial treatment, and further active local warming measures are not required. The patient's wet clothing should be removed and body parts dried and protected from trauma. Blisters should be left intact and sterile fluff dressings applied.

Temperature of the water in the immersion tub or whirlpool--if you are fortunate enough to have one available--should be maintained at 104 to 106° F. This temperature range is sufficiently warm to dissolve the ice in the tissue rapidly, but not so warm that the patient is uncomfortable or that you run the danger of tissue damage from excess heat. Under no circumstances should you allow the water temperature to exceed 112° F.

Take care to handle the part gently and do not massage it; if you do, you will cause further mechanical damage.

The thawing process is relatively quick but usually quite painful. The patient may require some sedation and analgesics for pain and some cases require narcotics such as morphine or meperidine (Demerol). Itching and urticaria may require local treatment.

As thawing proceeds, a pink flushing will progress distally down the extremity. Continue the immersion or whirlpool treatment until the distal tip of the thawed part flushes, is warm to the touch, and remains flushed when removed from the bath.

Sometimes you may find that the flushing is not pink but rather that of an ominous burgundy hue or even purple. Under other circumstances, that would usually spell trouble and indicate ischemia and a retention of venous blood. However, in frostbite, don't become alarmed. This color change seems to be directly related to the elevation of temperature of the warm water and is usually transient. It does not mean that you are on the wrong track.

Persistent cyanosis or ischemia, however, despite rapid thawing, may indicate increasing pressure within the fascial compartment due to an associated fracture, sprain, soft tissue injury, or concomitant disease. Whenever you see this problem, you must consider performing a fasciotomy.

With rapid thawing it is not unusual for sensation to return to the affected part as soon as the thawing process is complete. This sensation tends to be less than normal, but it is there temporarily, which is more than can be said for other methods of thawing. It disappears again when blebs or blisters develop and separate the epidermis from dermis, or the dermis from underlying tissues, and does not return fully until healing is complete.

Maintain deep body temperature of the patient with blankets and warm liquids. All individuals with cold injury of the extremities should be managed as litter patients with the involved limb slightly elevated. All cold injury victims should be evaluated by qualified Medical Department personnel as soon as possible. At the earliest opportunity, a thorough physical evaluation of the patient should be performed. There is always the possibility of a concomitant injury, particularly a

fracture or injury to the patient's head. Make sure that what appears and smells like alcoholic stupor is in fact alcoholic intoxication. If the patient appears to be in a diabetic coma, verify that he is really a diabetic.

Once thawing is complete, try to evaluate the extent of the injury. If you consider it to be severe and the penetration deep, the patient should be hospitalized. And since frostbite victims are frequently dehydrated, they may benefit from the administration of Lactated Ringer's Solution. Heparin or low molecular weight dextran may be indicated if vascular "sludging" or thrombophlebitis are suspected.

If the lower limbs were frozen, they should be elevated and kept on sterile sheets with protective cradles over them to avoid injury or pressure. Place sterile cotton pledgets between the toes.

If the injury is to hands or arms, it's enough merely to lay them on sterile sheets placed over the patient's chest and trunk.

To further ensure a sterile atmosphere, isolate the patient and require all attendants to be masked and gowned.

Treatment is open and nonocclusive. Don't use wet dressings, ointments, or petroleum gauze, which are seldom effective and tend to occlude and clutter up the injured area and generally get in the way of the thorough washing and irrigation that form the core of this phase of treatment. If available, use a whirlpool bath at least twice daily for 20 minutes at temperatures that are normal for the individual's skin and deeper structures, usually within the range of 90 to 95° F.

The whirlpool has many advantages. It cleases gently, removing superficial bacteria. It provides physiologic debridement and aids circulation. Surgical soap can be added to the whirlpool for its bacteriostatic effects.

Antibiotics are seldom used unless there is a very deep infection, both because the whirlpool does such a good job and because there is usually such widespread destruction of the vasculature in the impaired part that systemic antibiotics probably don't get to where they are most needed. If antibiotic therapy does become necessary because of a secondary infection, it should be guided by bacterial culture and sensitivity testing.

Antitetanus boosters should be given where indicated by associated trauma.

Exercises. Exercises are an indispensable part of the treatment and must be given as soon as possible. Physical therapy includes early active and passive movement of the affected parts and later rehabilitation of compromised function. Insist that the patient perform digital movements at least every hour, particularly while in the whirlpool bath. Softening the hard eschar makes the exercises more comfortable to perform. If possible, the patient should do Buerger's exercises for at least 20 minutes four times a day.

This constant active joint motion is particularly important in preventing flexion contractures of the digits, a common sequela of frostbite. It also has the psychologic benefit of showing the patient what he can do in spite of the grim appearance of his injury.

Blebs appear shortly after the initial rewarming process and should be left intact. Contents of these blisters are usually sterile and so are the underlying tissues. Debride obviously infected blebs with caution, since you are trying not only to minimize the risk of infection but also to give healthy tissues a chance to survive. Blebs generally rupture about the 3rd to 7th day, depending on the degree of injury and the activity of the patient. As they dry, they become hard.

Black circumferential eschars will usually develop. Whenever the eschar prevents motion of the digits, particularly the interphalangeal and metacarpal phalangeal joints, the eschar can be carefully split along the dorsum or lateral borders so that you avoid injury to the underlying neurovascular bundles. Don't try to remove the eschar, because the whirlpool will do that job for you at a physiologic rate, and you may cut into granulating membranes under the eschar and cause further scarring.

About the 10th to 14th day, and certainly by the 21st, after the eschar has begun to slough in the whirlpool and you are certain that healing is well underway, you can discontinue the isolation and sterile precautions. The whirlpool and active exercises should, however, be continued.

Some distal parts of an extremity may remain black and cold, indicating they probably won't survive. Debridement of these nonsurviving parts should be delayed until spontaneous amputation of the soft tissue is virtually complete. This may require from 3 weeks to 4 months. At that point you can remove the mummified portion surgically without danger of retraction of the distal tissue or of unnecessarily increasing the level of amputation. Skin grafting may become necessary as well as surgical debridement. Surgical sympathectomy may be indicated in severe cases of frostbite and immersion foot to relieve causalgia pain.

One exception that might require early surgical intervention is the extremity that has remained in a frozen stage for a considerable period of time, and after thawing you find a condition similar to anterior tibial compartment syndrome, with pain, severe edema, restricted joint motion, evidence of ischemia, and a marked increase in compartment pressures obviously compromising the blood supply.

Under these circumstances a fasciotomy and/or sympathectomy should be considered. The vascular response is almost immediate with the fasciotomy, while the sympathectomy appears to promote a much more rapid resolution of any infection that may be present, rapid diminution of edema, and a significant lessening of pain. The combination of the two procedures seems to speed the demarcation between healthy and nonviable tissue in the affected part.

Document all episodes of cold injury in the patient's medical records. Recurrent episodes may be sufficient cause for reassignment or a medical board.

AVOID rubbing cold-injured parts with snow, ice, or cold water, or traumatizing in any other way. This form of treatment was originated by Baron de Larrey, surgeon-in-charge of Napoleon's Grand Army on its retreat from Moscow in the winter of 1812. Dr. Larrey based his advice on his own personal observations of French soldiers who would thaw their frozen extremities before a roaring fire generating about 150 to 170° F. On the march the next day the extremities would refreeze with disastrous results.

- Avoid thawing in heat over 112° F.
- Avoid refreezing of the affected parts.
- Avoid the use of alcoholic beverages and tobacco, because of their effect on capillary circulation.
- Avoid ointments and creams.

FACTORS INFLUENCING COLD INJURY

WEATHER. The prevention of cold injury is facilitated by the availability of accurate meteorologic information, including air temperature, humidity, and wind velocity. For practical planning purposes, the cooling effect of air temperature and wind velocity has been combined into what is called the Wind Chill Index.

PHYSICAL WORK. Heavy physical activity may accentuate heat loss by perspiration. In addition, the moisture becomes trapped in excess clothing and reduces its insulating capacity. Prolonged or excessive activity leads to mental and physical fatigue which may lead to fatal hypothermia in a cold environment. Total immobility or inactivity, on the other hand, decreases production of body heat with cooling of the extremities and circulatory impairment in dependent body parts. It would seem advisable, therefore, to tread the middle ground and to recommend moderate activity with adequate rest. Increased exercise of the extremities should be encouraged when personnel are in confined positions in a cold climate.

PHYSICAL WELL-BEING AND GENERAL HEALTH. Persons with previous cold injury, especially of recent origin, heavy smokers, and those taking medication which affects the vasomotor tone are at special risk in cold environments. Seriously wounded individuals with significant blood loss and decreased activity are predisposed to cold injury, as are those on starvation or near-starvation diets. Consumption of alcoholic beverages causes vasodilation and a false sense of warmth but, unfortunately, accelerates heat loss and thus favors the development of frostbite and hypothermia. During the convalescent phase, minimal controlled alcohol may be allowed for the cold exposure patient. There is still a tradition and practice of issuing small individual bottles of brandy to pilots and other victims of cold water immersion.

PERSONAL CHARACTERISTICS. Although the epidemiologic reasons are unclear, younger lower ranking personnel, Caucasians geographically from climates with minimum January temperatures above 20° F, and American blacks appear to share an increased risk of developing cold injuries when exposed to cold environments. Persons with negativistic personality behavior patterns are also an increased hazard. Therefore, line commanders and Medical Department personnel may find it particularly valuable to concentrate their attention on these groups, as well as directing as much preventive education towards these individuals as possible.

CLOTHING. Protective clothing, available when needed and properly worn, is essential to conservation of body heat. Garments should be clean and should allow adequate air circulation between and through the layers of clothing. Apparel should be fitted so as to avoid peripheral limb constriction with attending circulatory impairment. The feet and hands require special care in order to avoid maceration of the skin and secondary infection. This is best accomplished by adequate changes of socks and gloves and liberal use of soap and water cleansing. When possible, footgear should be dried between periods of use.

PREVENTIVE EDUCATION. All personnel should be oriented to their individual responsibility in the prevention of cold injuries. Predisposing and preventive factors should be widely promulgated. Negative attitudes should be discouraged.

Cold injuries, like heat injuries, are for the most part preventable. In such situations you as physicians are going to be so busy treating other acute cases that the prevention of any cold injury is to your benefit, as well as in the patient's best interest.

IMMERSION FOOT

John F. Russo, LCDR MC USN

History

Baron de Larrey, Surgeon General of Napoleon's armies, recorded cases that he observed and treated during the retreat from Moscow in 1812. Larrey noted that trench foot occurred when the temperature was a few degrees above the freezing point and in the presence of water (during the thaw when rain was falling) and not during very severe cold. This observation has been confirmed many times by modern investigators.

Snow, cold rain, and mud were the contributing factors leading to trench foot during World War II, particularly when men were required to crouch for hours in foxholes or trenches. The combination of cold, wet boots and relative immobility led to a serious occurrence of trench foot among troops on the 5th Army front in Italy in 1944. The ratio of trench foot to battle casualties was 1 to 3½. Much of the pathophysiology of trench foot and immersion foot is similar. However, there appears to be a difference in the environmental factors contributing to these conditions.

Captain G. T. Anderson, MC USN, in a January 1966 report to the Surgeon General of the Navy described a condition affecting a number of casualties from the battlefield who required from 1 to 10 days on the sicklist before they could be returned to a duty status. This condition was called immersion foot. Most individuals have experienced a similar yet milder condition after prolonged soaking in a bathtub or swimming pool.

In April 1966 the senior medical officer of Operation Jackstay reported the evacuation of 60 Marines because of foot problems resulting from constantly wet feet. Although many of these were called immersion foot, all cleared promptly with cleansing and drying, and most returned to duty within 48 hours.

From these reports it is obvious that in the combat areas of Vietnam, as in previous wars, wet foot injuries are an all too common source of troop morbidity.

Adapted from supplement to Naval Medical School Kinescope prepared for Global Medicine Series, U.S. Navy, APR 1967.

Etiology

The factors affecting trench foot are: wet occlusion, cold, and stasis. The severity of the disease increases as these factors increase. Increases do not have to be linear. Different combinations will produce the same degree of severity. There is a point which is somewhat variable but where irreversible damage, such as gangrene, occurs.

Generally, the term immersion foot has been used in descriptions of a syndrome which developed after prolonged immersion in sea water. The predominant factors in immersion foot are cold and wet occlusion. Here again a variable point is reached where irreversible damage occurs. Stasis or immobility is not as large a contributing factor in immersion foot as cold and wet occlusion.

Prevention

Prevention of immersion foot in combat is an exercise in avoiding the circumstances that produce it. If it is possible for troops to dry their feet at intervals during a 24-hour period, the incidence of immersion foot will be negligible. It should be understood that operational movement in battle many times cannot lend itself to conditions necessary for the personal care required for the prevention of immersion foot. However, the fact that some control of this factor is possible suggests that it is an area of serious consideration by field commanders.

In general terms, any method that will keep feet dry during exposure to a wet environment is the prophylaxis against immersion foot.

Rubber boots have been suggested, but any advantage they may have must be measured against the possibility of developing immersion foot from accumulated sweat in the boot and from water leaking over the top of the boot.

Siliconized leather boots would have similar disadvantages. At this time there is no known way to change human skin so that it can tolerate the hostile insult of prolonged wet occlusion.

Symptomatology and Treatment

In reviewing the description of these disorders, it is obvious that much of the symptomatology is similar.

Trench foot. Described as a form of immersion foot caused by immersion in cold fluid mud (which freezes at a slightly higher temperature than sea water). In addition, mechanical interference with circulation by footwear is a contributing factor. Feet are cold, swollen, and discolored. A stage of intense hyperemia follows removal from causative conditions (pain is quite severe during this stage). Ischemic tissues are particularly prone to infection. Treatment is the same as for immersion foot.

Immersion foot. Caused by prolonged exposure to cold of insufficient degree to freeze tissues (e.g., tissues long immersed in cold sea water, which freezes at 1.9° C, cannot be frozen but are subject to continued chilling). Cases can occur, however, at temperatures of 15° C or even higher. Initial stage is severe peripheral vasoconstriction, caused by local and general cooling; element of ischemia present, to which nerve and muscle are sensitive. Vasoconstriction stage is followed by hyperemia, which is accompanied by severe pain and increased swelling. Pain is aggravated by heat, relieved by cold. In severe cases, a post-hyperemic stage may follow, in which there is instability of temperature with cold sensitivity, possible recurrence of swelling, and pain.

Treatment is by elevation of affected extremities and by exposing them to a cool environment (18-22° C), taking care to avoid overcooling; remainder of body kept warm. In hyperemic stage active cooling is begun as soon as vasodilation develops. Feet kept clean and dry; bed rest; proper footwear selection, etc.

Prognosis

The following chart depicts the prognosis of immersion foot for minimal, mild, moderately severe, and severe cases in terms of tissue and nerve damage, as related to recovery time.

Immersion Foot

Groups of Severity	Tissue Damage	Nerve Damage	Recovery Time
Minimal	Reversible None to transient	Reversible None to transient	Hours
Mild	Reversible Edema, Paresthesia	Reversible	Days to weeks
Moderately severe	Increased	Irreversible	Weeks to months
Severe	Irreversible Gangrene	Irreversible	6 months or more

In minimal cases the tissue damage is reversible. There may be no damage or only transient damage. There is no, or transient, interference with nerve function. Recovery time is a matter of hours.

In mild cases--and perhaps tropical immersion foot would also be in this category--tissue damage is reversible with some edema and paresthesia. Nerve damage is reversible; all signs disappear within weeks. Average hospital stay is 6 to 8 weeks. Patients are fit to return to full duty within 4 months after rescue.

Moderately severe cases usually show increased edema, paresthesia, and other signs of faulty circulation. Nerve damage is irreversible. Average hospital stay is 9 weeks to 6 months. Only 25% recover sufficiently to return to full duty; most of remainder are able to do light work.

Severe cases are those in which irreversible tissue damage occurs, such as gangrene. Nerve damage also is irreversible; gangrene is invariably present. Extensive anesthesia is present 6 months after rescue. Average hospital stay is at least 6 months. Few cases become fit even for light duties in the services.

RESUSCITATION OF ACCIDENTAL HYPOTHERMIA VICTIMS

Murray P. Hamlet, D.M.V.

The recognition of hypothermia as a serious medical emergency is the first step to successful resuscitation. Patients often present cold, cyantoic and pale, stiff as if in rigor with no palpable pulse, no audible heart sounds, no visible respiratory excursions and fixed pupils. They may be in various states of undress and if cooled in a crouched or huddled position impossible to straighten out on an examination table. Their EKG may be extremely bizarre ranging from flat to ventricular fibrillation. Because patients have been successfully resuscitated at core temperature of 64°F with flat EKGs, the axiom here is "no one is dead until he is warm and dead; attempt rewarming and resuscitation of all cold patients."

There are essentially three types of hypothermia: acute, subacute and chronic, and each has specific requirements for resuscitation and clinical management. Acute hypothermia results from rapid cooling, such as seen in cold water immersion. This acute drop in core temperature is accompanied by few metabolic, electrolyte, and pH abnormalities other than those caused by the direct effect of temperature. The slow cooling rate of chronic hypothermia is usually produced by alcoholic stupor, barbiturate overdose, endocrinopathies, stroke, etc., that subject a person to long-term cold exposure. Slow cooling produces severe alterations in pH, electrolyte balance, and serious alterations in fluid volume. This occurs as the normal physiologic defense mechanisms against cold attempt to counteract the cooling process. The subacute hypothermic patient falls somewhere inbetween, that is, as alcohol inhibition, rain, heavy winds, poor clothing, etc., subject him to varying cooling rates.

Careful analysis of the immediate prior history can lead to determination of both how and at what rate the patient became hypothermic. Both will impact on how they are handled in the emergency room and in the hospital. Keep in mind that freezing temperatures are not necessary for the production of hypothermic patients.

A composite of clinical and experimental literature compiled at the U.S. Army Research Institute of Environmental Medicine, Natick, Mass. in 1976.

Resuscitation Tips:

1. Low reading clinical thermometers should be readily available in the emergency room.

2. Core temperature should be taken rectally and is a reliable indication of the progress of rewarming.

3. Careful handling of the patient is essential. Any changes in body position or rough handling can initiate ventricular fibrillation.

4. The blood glucose levels of hypothermic individuals may give a clue to the type of cooling that occurred. Acute hypothermia produces hyperglycemia, while chronic and subacute cooling produces hypoglycemia. The long term shivering of the chronic hypothermic utilizes vast amounts of blood glucose, and, conversion of glycogen to glucose decreases as temperature decreases.

5. Atrial fibrillation is more common in acute than in subacute or chronic hypothermia.

6. Renal failure after rewarming is more common in chronic hypothermia.

7. Current British literature suggests that in acute hypothermia, rapid external rewarming is usually indicated. In chronic hypothermia, they prefer slow rewarming to allow for reversion of metabolic aberrations. This author feels, however, that rapid internal rewarming of chronic hypothermia is a more physiologic procedure.

Physiology of Hypothermia

Hypothermia, the lowering of core body temperature to 94°F or below is a potentially lethal disorder requiring aggressive therapy. As body temperature decreases below 94°F, central nervous system functions are depressed. Initially, patients exhibit behavioral changes, then depression of consciousness, culminating in coma. The respiratory center is progressively inhibited until apnea supervenes. Cardiac output falls to such extent that despite maximum peripheral resistance the blood pressure falls. The pulse rate decreases. Conduction and heart rhythm abnormalities occur. The "J" wave, various degrees of heart block, atrial premature contractions (APC's), atrial flutter and fibrillation, ventricular premature contractions (VPC's), ventricular tachycardia and fibrillation (VF), and if the patient is cold enough, ventricular

standstill can take place. The shift of water out of cells and the intravascular space into the extracellular space as well as decreased renal tubular fluid resorption can render the patient hypovolemic. Some profoundly hypothermic patients exhibit a syndrome similar to disseminated intravascular coagulation (D.I.C.). Since insulin release and glucose utilization decline with temperature, blood glucose tends to be normal or elevated. Acid-base and electrolyte parameters are little affected by temperature alone but are often deranged by the disorder underlying the hypothermic episode.

The physician must bear in mind that patients who present with hypothermia often have underlying disorders which prevent appropriate physiological responses to the cold environment. Such illnesses include stroke, central nervous system trauma, shock, sedation, use of tranquilizer, or ethanol overdose, endocrinopathies like myxedema and hypoadrenocorticism, hypoglycemia, and old age.

Over medication while cold is a common problem. Subsequent rewarming brings patient into toxic areas for the drugs used. Most drugs are contraindicated in early hypothermia resuscitation.

Much controversy exists over which method of resuscitation, that is, active or passive, external or internal, yields the lowest mortality. The most frequent mechanism of death from hypothermia itself is ventricular fibrillation or standstill. These events can occur at temperatures in the mid 80°'sF (27°C) and below. Apnea can occur somewhat higher but usually occurs at lower levels. External warming techniques, active or passive, can actually increase the likelihood of fibrillation during the early phase of resuscitation. The application of heat to the body surface causes peripheral vasodilation, leading to the draining of heat away from core organs, the return of large volumes of cold blood to the core and thus the lowering of core temperature to increasingly dangerous levels, and a drop in the already low blood pressure. Although this reasoning militates for methods of rewarming the core before the periphery, as through peritoneal dialysis and extracorporeal blood rewarming, the literature suggests that with close monitoring and rapid correction of life-threatening aberrations, external rewarming, both active (with a heated bath or hypothermia blanket), or passive (by wrapping the patient in blankets to prohibit the escape of body heat) yield high survival rates. The author feels that it is physiologically more reasonable to use active than passive methods.

Because of the potential for cardiopulmonary death, the hypothermic patient must be admitted to the intensive care unit. Skull and chest x-ray, blood gases, electrocardiogram, blood count, BUN, creatinine, electrolytes, amylase, calcium, blood sugar, fibrinogen, prothrombin time, and platelet count will help in immediate management. If possible the attending physician should be cognizant of the mechanism of the patient's loss of proper thermoregulation. Continuous electrocardiographic monitoring should be instituted. Bizarre EKG tracings are to be expected. Respiratory support including intubation and mechanical ventilation is almost mandatory to keep the supply of oxygen ahead of the rewarming organ demand. Care should be taken during intubation as any rough manipulation can lead to ventricular fibrillation. Ventricular premature contractions are abolished by lidocaine infusion and correction of hypoxia and acidosis. APC's, atrial flutter, and fibrillation will spontaneously revert to normal without medication as cardiac temperature approaches normal. Atropine and electrical pacing have little beneficial affect on conduction in the hypothermic heart. On the contrary the irritation of the myocardium by the pacemaker electrode itself or by its discharge can lead to VF. If ventricular tachycardia fails to respond to lidocaine or if VF takes place, rapid extracorporeal blood rewarming must be instituted immediately. Because the hypothermic heart is unresponsive to countershock, cardiac temperature must be raised before cardioversion can be successfully accomplished. In such emergencies, the cardiopulmonary bypass machine, equipped with heat exchanger, connected to the femoral artery and vein has been successfully employed. Like any cardiac arrest this situation calls for continuous closed cardiac compression and forced ventilation until the appropriate machines can be placed in operation.

Hypoxia and acidosis are major factors predisposing to ventricular arrhythmias. pH, PCO_2 and PO_2 may appear to be low but may in fact be correct for the organ and brain demand at the depressed temperatures seen in hypothermia. Blood gases and pH, corrected for temperature, should be determined, and abnormalities corrected by adjustment of respiratory parameters or bicarbonate infusion, whichever is necessary to manage bronchorrhea, the physiological response of the airway to exposure to cold air. The rate of spontaneous respiration will increase as the temperature rises.

Maintenance of the central venous pressure at 5-10cm water, with suitable volume expanders, will insure that intravascular fluid volume keeps pace with the capacity of the intravascular

space, enlarging in response to peripheral vasodilation which in turn is caused by external rewarming. Thus, when cardiac temperatures and correspondingly cardiac output and heart rate begin to rise, blood pressure will follow suit. Avoid the use of pressor agents which have no effect on the maximally constricted vessels but which increase the likelihood of ventricular arrhythmias. Similarly, in order to avoid myocardial irritation leading to VF the CVP catheter tip should not be advanced into the heart until some degree of rewarming has occurred and the myocardium is not exceptionally sensitive to physical irritation by the catheter tip. As with respiration, the heart rate will rise spontaneously with temperature. Begin intravenous heparin therapy if clotting tests indicate the occurrence of a DIC-like syndrome.

Other fluid, electrolyte and metabolic abnormalities should be treated as the clinical situation dictates. Therapeutic doses of steroids may be given if hypoadrenocorticism is suspected. Because of the high failure rate of resuscitation of hypothermic myxodematous patients, the latter state must be recognized and treated immediately. After the patient's condition has stabilized, perform whatever additional studies are called for to determine the disease process underlying the hypothermic episode.

Hypothermia Checklist

1. Recognize that the patient is hypothermic - use low temperature thermometer.

2. For patients with compromised mental status or cardiovascular irregularities intensive care is necessary.

3. History of predisposing disease - (Myxedema, hypoadrenocorticism, etc.).

4. Begin, continuous or frequent temperature recording with low temperature recording thermistor or thermometer.

5. Install I.V., (possibly an arterial line), C.V.P., foley catheter (may be extremely difficult).

6. Begin continuous cardiac monitoring.

7. Frequently monitor vital signs and urinary output (at least every hour or more frequently as necessary during rewarming).

8. Wrap patient in rewarming blanket and set to as high a temperature as can be tolerated without burning the patient (104-110°F).

9. Give respiratory support - oxygen by mask or by endotracheal tube (may produce VF) with mechanical ventilation - Aim for high PO_2 normal pH and PCO_2, and clearance of secretions. Monitor arterial gases and pH as frequently as necessary.

10. Tests: CBC, BUN, creatinine, electrolytes, glucose, amylase, calcium, fibrinogen, prothrombin time, platelet count, chest and skull x-rays, 12 lead EKG, arterial blood gases and pH (corrected to core temperature).

11. Maintain CVP between 5 and 10 cm with appropriate expanders or fluids calculated to correct electrolyte imbalance gradually.

12. Give bicarbonate to correct acidosis.

13. Treat VPC's with standard boluses 15mg/kg of lidocaine and the correction of hypoxia and acidosis. If ventricular tachycardia, fibrillation, or standstill occur begin closed-chest cardiac compression and assisted ventilation until extracorporal blood rewarming can be instituted with cardiopulmonary bypass with heat exchanger. Electrical cardioversion will succeed when the heart warms sufficiently. Atrial premature contractions, flutter and fibrillation will revert to normal with rewarming.

14. Give therapeutic doses of corticosteroids or thyroid hormone if called for.

15. Give heparin for a DIC-like syndrome.

Therapeutic Outline for the Hypothermic Patient with Consideration of Peritoneal Dialysis

I. Immediate cardiorespiratory support will, of course, be the first concern, but in the severely hypothermic patient, vigor and rates of resuscitation and dosages of medications should be reduced until patient has begun to reach a more normal temperature.

II. Respiratory considerations:

A. Initially respiration is depressed - decreased rate, volume.

B. Must secure a patient airway which probably means intubation.

C. Oxygen frequently should be given by mask or endotracheal tube (tube may produce VF).

D. Bronchorrhea is common response to cold injury.

E. Chest x-ray will be required later.

III. EKG and continuous rectal temperature monitoring needed initially to determine if patient is, in fact dead.

A. Criteria to proceed:

1. Any electrical activity on EKG (may look artifactual).

2. Any respiratory effort.

3. Absence of pulse, blood pressure, or heart sounds are not adequate for pronouncing death. Neither pupillary dilation nor non-response to light is enough. DTR's may also be absent.

B. Pronouncing dead:

1. May be very difficult decision - probably only guideline is that resuscitation and rewarming of all patients must be attempted.

2. History of long term exposure if A-1, 2, 3, absent.

3. Rectal temperature less than $50^{o}F$.

IV. Rewarming should follow closely with resuscitative efforts.

A. Establish IV line, CVP line (cut down may be necessary as venous filling is poor and vessels will be difficult to raise. CVP tip must be kept out of heart early to prevent arrhythmia. Maintain CVP between 5-10cm water with appropriate fluids, volume expanders. Warm IV fluids to $42^{o}C$ before use.

B. Concentrate on core rewarming (i.e., peritoneal dialysis) and specifically avoid the application of shell heat initially.

C. Gray zone of when to dialyze.

1. At 90 degrees or greater, one can probably use conservative modalities (i.e., active external rewarming).

2. AT 87 degrees or less, dialysis should definitely be utilized.

3. Some recommend dialysis if less than 94°F.

D. Monitor urinary system. Record output, measure specific gravity, Na, and K.

E. Baseline blood studies - probably should not use as indicator for immediate treatment - CBC, Na, K, Cl, CO_2, BUN, amylase, glucose, pH, PO_2, PCO_2, Ca, fibrinogen, platelets, pro time.

F. Dialysis protocol should proceed as per routine in cases of dialysis for renal failure except that exchanges are far more rapid. Bottles should be heated to 45°C and fluid will be about 40-42°C after passage through tubing and arrival at abdomen. Each exchange should take approximately 20 minutes. Two liters should be run in as fast as bottle elevation and tubing length will allow.

1. Add NO K to dialysate due to possibility of acute renal failure and sensitization of myocardium to VF.

2. Add 1000 units heparin per bottle to prevent clotting of dialysis system.

3. Culture first, fifth, and every tenth exchange.

V. Complications of hypothermia

A. Cardiac - arrhythmias are biggest concern.

1. At low temperatures may have intractable response in cardioversion and may wind up:

a. Trying repeated ineffective shocking causing chest burns.

b. Using entirely too much drug for effect at the hypothermic level which then winds up at toxic levels upon rewarming.

2. Xylocaine is probably drug of choice for most arrhythmias given at 15 mg/kg in a bolus or 100 mg total.

3. Defibrillate prn.

4. Atrial premature contractions, flutter, and fibrillation should revert to normal with warming.

5. With only slow normal EKG/cardiac response, one probably need not apply active CPR.

B. Psychiatric problems may result

1. Patient must be restrained on rewarming due to possible hyperactivity, disorientation, etc.

2. After rewarming, patient may look extremely well but should not be released without adequate observation period (24 hours plus).

C. Pneumonia may ensue. Prophylactic antibiotics should be considered.

1. Poor respiratory effort.

2. Bronchorrhea due to cold injury.

D. Renal failure - be forewarned by hypertension post rewarm.

E. Pancreatitis is a common post rewarming sequella in all types of rewarming.

F. Diabetic keotacidosis.

G. Disseminated intravascular coagulation - Rx with heparin.

H. Myocardial infaraction.

I. Gastrointestinal bleed.

J. Hypotensive episodes.

K. Peritoneal infections secondary to dialysis.

L. Ileus.

Patients should be kept absolutely NPO. Continuous monitoring of rectal temperature, EKG, and blood pressure is absolutely essential.

Summary

Once diagnosed, start rapidly on rewarming then continuously monitor with minimal interference as the patient recovers.

Further questions can be directed to:

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